Domestic Appliances Repairer

Instructional-cum-Practical Manual

Volume VI

A.P. VERMA
Project Coordinator

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

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FOREWORD

The programme of vocationalization of higher secondary education has been accepted by the country as it holds forth great promise for linking education with the productivity and economic development of the country by providing education for better employability of the youth

In view of the importance of the programme, the NCERT is making an all-out effort to provide academic support to the implementing agencies in the States. One of the major contributions of NCERT is in the field of curriculum development and in the development of model instructional materials The materials are developed through workshops in which experts, subject specialists, employers' representatives, curriculum framers and teachers of the vocational course are involved

The present manual on Domestic Appliances Repairers (Vol. VI) is meant for the students of this course. It is being published for wider dissemination amongst students and teachers throughout the country. I hope that they will find the volume useful.

I am grateful to those who have contributed to the development of this volume. I must acknowledge also the immense interest taken by Prof. A K Mishra, Head, Department of Vocationalization of Education in inspiring his colleagues in their endeavours to develop instructional materials. Dr A.P. Verma, Reader (Technology) functioned as the Project Coordinator for the development of this title. He has my appreciation and thanks for planning, designing and conducting the workshop, for technical editing and for seeing this title through the press.

Suggestions for improvement of this volume will be wecome.

K. GOPALAN
Director
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PREFACE

Ever since the introduction of vocationalization of education in our school system by several States and Union Territories in our country, the paucity of appropriate instructional materials has been felt as one of the major constraints in the implementation of the programme and a source of great hardship to pupils offering vocational studies at the Higher Secondary Stage.

The Department of Vocationalization of Education of the National Council of Educational Research and Training, New Delhi has started a modest programme of developing instructional materials of diverse types to fill up this void in all major areas of vocational education. The task is too gigantic to be completed by any single agency but the model materials being developed by us might provide guidance and impetus to the authors and agencies desiring to contribute in this area. These are based on the national guidelines developed by a working group of experts constituted by the NCERT.

The present manual is on Domestic Appliances Repairer and is meant for the students and teachers of the course which is being offered in various States and Union Territories under varying names, viz., Electrical Appliances, Electrical Appliances Repairs, Electrical Domestic Appliances Repairs and Maintenance, Electrical Domestic Appliances and Rewinding, Electrical Wiring and Servicing of Electrical Appliances, Maintenance and Repairs of Domestic Appliances etc The present manual is the sixth volume in a series of six volumes which cover the course. It contains practical exercises to be performed by the students with simple steps to follow, precautions to be taken and data to be observed and recorded in observation sheet. Each experiment is complete with brief theoretical information, specific objectives, review questions, etc It is hoped that the users will find the manual useful.

The experimental edition of the manual was developed during a workshop held at NCERT, New Delhi. The names of contributors and reviewers are mentioned elsewhere and their contributions are admirably acknowledged. Dr. A P. Verma, Reader and Coordinator of the project, in the Department of Vocationalization of Education deserves special thanks for technical editing and for bringing the material in its present form.

The assistance of all in the Department of Vocationalization of Education, NCERT is thankfully acknowledged.

ARUN K. MISHRA
Professor and Head
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GANDHIJI'S TALISMAN

"I will give you a talisman. Whenever you are in doubt or when the self becomes too much with you, apply the following test :

Recall the face of the poorest and the weakest man whom you may have seen and ask yourself if the step you contemplate is going to be of any use to him. Will he gain anything by it ? Will it restore him to a control over his own life and destiny ? In other words, will it lead to Swaraj for the hungry and spiritually starving millions ?

Then you will find your doubts and your self melting away."

M K Gandhi

CONTENTS

Introduction

With the advent of easy availability of electrical power, electrical domestic appliances have become more important in our day-to-day life. Tasks like washing, ironing, cooking, mixing, room cooling and heating are easily achieved through the use of these devices. This is mainly due to the fact that these appliances are freely avilable at a price that is affordable by middle income group families. Therefore, it has become important to understand the complete methodology of the repair of these appliances. Further, there is need to ensure that access to repair of these appliances is available at nearby places and within the reach of the common man Trained persons in this area, should, therefore, have a good understanding of the principles on which these appliances are based. They should also know the technique of dismantling and reassembling these appliances. With this motivation, a group of experiments have been given in the area of electrical domestic appliances.

The trained man in this area should have thorough knowledge of various wiring schemes so that he may be able to detect the faults and at the same time replace them with a new wiring set. Experiment No. 1 gives the details of different types of wiring and their field of application and uses with an intention to determine when and where a particular wiring should be used. The student will be required to draw the layouts and fabricate various types of circuits commonly employed in the domestic wiring. Experiment No. 2 refers to conduit wiring and has been sub-divided into two parts which are as follows.

1. Surface type
2. Concealed type

In each wiring layout, either one circuit socket is to be wired or the fan and a power point has to be drawn. With these two experiments in wiring, it is expected that the student shall develop an understand of the "how" of wiring system as well as its working.

Distribution and service connection boards are employed in houses for distributing different circuits and also making arrangements, servicing, fault check-up and installing the protective devices. Experiment No. 3 is designed with this objective. The testing of wiring installation comprises an important area and its know-how must be grasped by the students thoroughly. This is basically due to the fact that failure of such installations may take place quite often and, therefore, detection of the faults and replacement of the faulty circuits by healthy ones must be done. This is explained in experiment No. 4. Faults in the wiring installations may be of various types e.g. line-to-ground, line-to-line, short circuit, open conductoring and leakage pathing, etc. It is, therefore, necessary that the students must know all types of faults of the above nature in the wiring installations, using the proper equipment and tools, as given in experiment No. 5. A complete procedure for rectification of faults is given in this experiment.

Neat and clean soldering for making permanent contacts to have a proper functioning of circuits is very necessary since improper functioning may lead to leakages and improper flow of currents Soldering is commonly done using electric soldering-irons and care must be taken while doing it. Further, on many occasions, a soldering iron may fail to function due to some internal fault. This has to be tested and repaired. This has been given in experiment No. 6. Electric bells, very commonly and cheaply employed as call bells in homes, nevertheless to give trouble and faults take place in them, therefore, students must have clear-cut knowledge regarding the procedure for testing and repairing of an electric bell, besides knowing its connections completely. This is given in experiment No 7.

Heating elements are used in electrical heaters, room heaters, electrical irons, kettles, geysers, hair driers, etc. The heating element varies from one appliance to another, but the basic principle remains the same and is based on power dissipation in resistors. A complete design procedure and a methodology for fabrication of the heater element is given in experiment No. 8. Various types of heaters, hot-plates and room heaters have proved to be a part of our daily life. In order to understand the functions and testing, assembling and reassembling of different types of heaters, experiment No. 9 gives all the details pertaining to the above. Various types of electric irons e.g. non-automatic, semi-automatic and completely automatic, are available in the market for ironing of clothes made of various kinds of fabric. It is known that the different fabrics will have different ironing temperature requirement. Therefore, regulated heat control using a thermostat for a temperature control is very necessary. A thermostat is mainly a device that is fitted in the appliance

for such a control. The knob indicator on the top of the iron indicates the names of various fabrics and the temperature is maintained accordingly by adjustment of the thermostat. Complete details of various components, testing procedures, dismantling and reassembling of an iron has been outlined in experiment No. 10

The toasting of bread is commonly done using electric toaster. The complete study, method of testing, dismantling and reassembly for all varieties of electric toasters e.g non-automatic, semi-automatic and automatic are given in experiment No. 11.

The electric oven/cooking range is an essential appliance in the modern family kitchen. From cooking to baking and grilling, these cooking ranges are used on a large scale. Ovens are generally used for the preparation of cakes, pastries and other confectionery items. The complete description of an electric oven/cooking range as well as the testing procedure and the technique of dismantling and reassembly are given in experiment No. 12.

Immersion heaters are generally used for the heating of water. Electric kettles and geysers are also used as boilers. These two aspects have been given in experiment Nos 13 and 14 where the student will study the test and repair of these items.

Table fans, ceiling fans, exhaust fans are used for blowing of air, for varying requirements ranging from low to large quantity. The study, testing, dismantling and reassembling of these type of fans have been given in experiment Nos. 15, 16 and 17.

The pump motor used in domestic appliances has a requirement of low power consumption and is of the fractional horse power variety. Similarly, motors employed in electrical mixers and hair driers are also of this nature Nevertheless their functions and applications are different. The pump motors are either employed for pumping water in low head areas/low pressure areas or for circulating water in room coolers. The electrical mixer is designed for use in the kitchen and hair driers for drying hair, films, paints, etc. The study, testing, dismantling and reassembling of these have been detailed in experiment Nos. 18 to 20. The complete description of a washing machine is given in experiment No. 21 and of a clothes drier in experiment No. 22 wherein the student shall study its function and go through the systematic procedure for its testing, dismantling and reassembling.

Estimation and costing constitute an important area for working out the involvement of material for the job undertaken by the trained man. He should, therefore, prepare a list of material in an economical manner so that the cost may be minimized. This is given in experiment No. 23. Further, after passing out from this course, the student may be required to organize a repair shop of his own It, therefore,

becomes obligatory for him to know a scheme for organizing a shop. He must know the list of equipment, materials and tools besides a few small machines required in the shop so that a given repair job may be undertaken by him. Keeping this in view, experiment No. 23 has been designed for organizing a repair shop.

It is, therefore, expected that if the student goes through these experiments during this training schedule and tries to work on the job himself after procuring the equipment and materials listed in the various experiments, he will not only have a thorough knowledge but will also be able to do the repair work confidently. The whole scheme has been designed so that the outcome may be trustworthy.

Experiment No. 1

Title of Experiment

To study different types of wiring, to compare them and to determine their uses.

Specific Objectives

(i) To know the various types of wiring systems.

(ii) To know their specific uses and applications.

(iii) To make a comparison of the various types of wiring systems.

(iv) To study the features of various wiring systems.

Introductory Information and Related Theory

The types of internal wiring usually employed in our country are the following:

(i) Cleat wiring.

(ii) Wooden casing and capping wiring.

(iii) C.T.S. or T.R.S. wiring (Batten wiring).

(iv) Lead sheathed wiring.

(v) Conduit wiring.

(a) Surface or open type.

(b) Recessed or concealed type.

A comparison of these types of wiring is given in the following table:

S.No.	*Particulars*	*Cleat Wiring*	*Wood Casing Capping*	*T.R.S. Wiring*	*Lead Sheathed Wiring*	*Conduit Wiring*
1	2	3	4	5	6	7
1.	Material required	Cleats, VIR cables, screws, gutties, blocks, boards, etc.	Teak wood and casing and capping, VIR cables, wooden gutties, screws, blocks, boards, etc.	Teak wood batten, T.R.S. cables, wooden gutties, screws, nails, link clips, boards, etc.	Teak wood batten, lead sheath cables, wooden gutties, screws, clips or joint clip boards,	Conduit pipes, VIR or PVC cables or pipe hooks, wooden gutties, screws, I.C. boxes,

1	2	3	4	5	6	7
					round boards, etc.	I.C. bends, tees, etc. with IC sockets and screws.
2	Cost	Very low	Medium	Low	Costly	Very costly
3.	Voltage	Low (upto 250 V)	Low (upto 250 V)	Low (upto 250 V)	Low (upto 250 V)	Low or medium (upto 600 V)
4	Live	Very short	Long	Long	Long	Very long
5.	Protection against fire	Poor	No	Fair	Good	Very good
6.	Mechanical Protection	No	Fairly good	Good	Fairly good	Very good
7	Dampness protection	No	Poor	Good	Good	Fairly good
8.	Appearance	Not good	Fair	Good	Fair	Very good
9.	Type of labour required	Semi-skilled	Highly skilled	Skilled	Skilled	Highly skilled
10.	General reliability	Poor	Good	Good	Fairly good	Very good
11	Additions or alterations to the existing wiring	Very easy	Difficult	Easy	Not very difficult	Most difficult
12.	Number of points that can be wired per day by a wireman with a mate	5	3	4	3	2
13.	Field of application	For temporary installations e g. functions, marriages, etc.	For residential, commercial and office buildings but now-a-days being replaced by TRS wiring on account of additional advantages.	For residential, commercial and office buildings	Only used for service, mains, etc.	Mainly for godowns, workshops and public buildings

General Rules for Wiring

1. Every installation must be properly protected near the point of entry of the supply cables by a two pole linked main switch and a fuse unit. In a two-wire installation, if one pole is permanently earthed, no fuse, switch or circuit breaker must be inserted in this pole. A 3-pole switch and fuse unit is used in 3-phase supply.
2. The conductor used should be of such a size that it may carry load current safely.
3 The conductors installed must be the same in all respects.
4. Every sub-circuit must be connected to a distribution fuse board.
5. Every line (positive or phase) should be protected by a fuse of suitable rating as per requirements.
6. A switchboard is to be installed in such a manner that its bottom lies 1.25 metres above the floor.
7. (a) Every socket outlet is to be controlled by a switch.
   (b) The switch controlling the outlet should be on the live (positive or phase) side of the line.
   (c) In an earthed system of supply, the socket outlet with plug should be of the three-pin type with the third terminal connected to the earth.
8. (a) All incandescent lamps, unless otherwise required, shall be hung at a height of 2.5 metres above the floor level.
   (b) Unless otherwise specified, all ceiling fans should be hung 2.75 metres above the floor.
9. Each sub-circuit should not have more than 10 points of light, fans and socket outlets and load of 800 watts.
10. No fuse and switch must be used in an earthed conductor.
11. Every circuit of apparatus must be provided with a separate means of isolation such as a switch.
12. All apparatus requiring attention must be provided with a separate means of isolation such as a switch.
13. All motor control switches must be easily accessible to the operator.
14. In any building, light wiring and power wiring should be kept separate.
15. In the three-phase, four-wire system installation, the load should be equally divided on all the phases.
16. Special care must be taken of the apparatus and conductors which are exposed to the weather, corrosive atmosphere or other adverse conditions.
17. No additional load should be connected to an existing installation unless it has been ascertained that the installation can safely carry the additional load and that the earthing arrangements are adequate.
18. Lamp holders in bathrooms should be constructed of, or shrouded in, insulating materials and fitted with a protective shield, and the earth

continuity conductor should not be of a size less than 7/0/915 mm.

19. The metal sheaths or conduits for all wiring and metal coverings of all consuming apparatus or appliances must be properly earthed in order to avoid danger from electrical shock due to leakage or failure of insulation.
20. All light conductors should be insulated or otherwise safeguarded to avoid danger.
21. Each circuit should be protected against excessive current (that may occur either due to overload or due to failure of insulation) by a fuse or automatic circuit breaker.
22. A caution notice (danger plate) written in Hindi or the regional language should be fixed permanently on every motor generator, transformer and other electrical equipment and also on all apparatus used for control or regulation at medium voltage (upto 650 volts) supply.
23. After completion of work, the installation should be tested before energization.

Equipment and Materials

Refer to S.No. 1 of comparison of various systems of wiring, wherein the material requirement for each type of wiring is given. Procurement of these wiring matrials should be made by the students.

Circuit Diagram

No circuit connection is needed for this experiment. Study the different materials and note the differences between them.

Procedure

Go through the description of various systems of wiring and make a comparative study. For example, the cost of the conduit wiring system is very high. This is so because of the costly material and labour requirement but this type of wiring system is suitable whenever wiring upto 600 V is required. In a similar manner, the life of cleat wiring is very short. Why? Therefore, go through every aspect of each wiring system and examine the merits and demerits of each. Make some layouts with different dimensions for different types of wiring and work out the details of the material requirement.

Tabular Record of Observations

(i) Tools for various types of wiring.
(ii) Conductors for various types of wiring.
(iii) Wiring accessories for each system.

Precautions

The following precautions should be considered when choosing a wiring system:

(i) *Safety*: The first and formost consideration is the safety of the people using electricity and protection against leakage or shock. Where there is a possibility of fire hazard, conduit wiring must be used.
(ii) *Mechanical Protection*: The wiring must not get damaged mechanically during use.
(iii) *Permanence*: The wiring must not

deteriorate unduly by action of weather, fumes, dampness, etc.

(iv) *Appearance*: The wiring must have a good appearance.

(v) *Building consideration*: The choice of wiring should be made keeping in mind the type of building to be electrified

(vi) *Durability*: The wiring must be durable.

(vii) *Accessibility*. There should be facilities for extension, renewal or alterations in the wiring system.

(viii) *Cost*: The wiring system selected should suit the pocket of the owner of the building.

Questions for Evaluation

(i) What is meant by house wiring?

(ii) Why are different types of wiring made for different applications?

(iii) State the factors to be considered in choosing a wiring system.

(iv) What are the advantages and disadvantages of conduit wiring?

(v) What are the merits and demerits of the cleat wiring system?

(vi) How will you make an evaluation of the material requirement for a given wiring layout?

References

(i) *Electric Wiring Practice* by Ibitson.

(ii) *A Textbook of Electrical Estimating and Costing in RMKS System* by J.B. Gupta, Katson, Publishing House, Ludhiana.

(iii) *Electrical Wiring, Estimating and Costing* by S.L. Uppal, Khanna Publishers.

Experiment No. 2

Title of Experiment

To wire up a surface conduit with one light, one fan point and one 3-pin floor socket.

Specific Objectives

(i) To plan the circuit, fix the conduit with bends and components on the wall.

(ii) To draw wires through the conduits, make connections to switches, regulator, socket, fan and light points.

(iii)To test the circuit.

Introductory Information and Related Theory

Conduit wiring is carried out to ensure safety against fire risks, better mechanical protection, to avoid accidents and ensure a longer life, with ease in conducting repairs. There are two circuits, one for the three-point power socket controlled with its own switch, is meant for connection of any electrical appliance, e.g. table lamp, radio, electric iron, requiring a maximum current of 5 amps.

The second circuit is meant for a ceiling fan and is controlled by an on/off switch and fan regulator.

Tools and Materials

Combination pliers, screwdrivers, hammers, drilling machine with masonry bit, conduit die. File flat 25 cms, file round 20 cms, oil can, pipe vice, insulation resistance tester 500V, cold chisel 15 cms, hammer cross-pane 1 kg., cement sand trowel, 4 clamps.

Materials

Conduit pipe, elbows, bends for the conduit C.I. round boxes, switchboard, flush switches, 3-pin socket, 1 mm^2 PVS copper wire, fan regulator, conduit saddles, rawl plugs, wooden screws of assorted size, switch single way 230 V. 5 A and 16 amps, ceiling rose bakelite two-plate, wall socket, 3-pin 230 V 15 A, bare copper wire 14 SWG/aluminimum wire 14 SWG.

Circuit Diagram

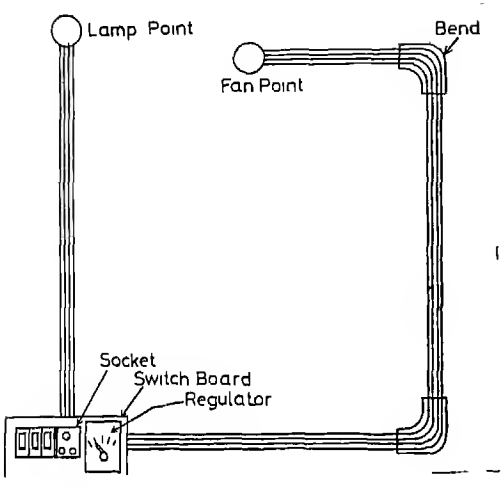

Fig. 2.1 Layout for Conduit Wiring for a Given Circuit.

Procedure

(a) *Surface type of conduit wiring*

(i) Make the layout for the wiring practice on the board with chalk as per given layout.

(ii) Cut the conduit pipes to the required length.

(iii) Adjust the conduit die to the dimension of the conduit pipe.

(iv) Mark on the conduit pipe for the length of threads to be inserted in any conduit accessory.

(v) Hold the pipe in the pipe vice and thread.

(vi) Drill holes for fixing the batten and fix on the marked layout.

(vii) Fix the conduit accessories with the threaded conduit lengths as per layout and fix on the board with the conduit saddles.

(viii) Insert the G.I. fish wire through the inspection holes of the conduit accessories

(ix) Insert the P.V.C. insulated wires of size by pulling with fish wire; also insert the earth wire of required size.

(x) Fix the wiring accessories e.g. switch, socket, ceiling rose, etc. over the conduit accessories and make the connection as per the circuit diagram

(xi) Test the wiring installation for insulation resistance, continuity, polarity and earth continuity by the insulation resistance tester 500 V.

(xii) Connect the installation with the supply mains and test.

(b) *Concealed conduit type of wiring*

(i) Make the layout on the walls and ceilings with the cut mark by a cold chisel

(ii) Chisel on the walls and ceiling about 3.5 to 4 cms deep on the marked layout.

(iii) Repeat steps a(iii) to a(v) and a(vii).

(iv) Hold the conduit frame work in the chasing by fixing U-clamps.

(v) Make mortar with cement and sand in the ratio of 1:6 and plaster the casing. See that the inspection covers of the conduit accessories remain level and meshed with the plates.

(vi) Repeat steps a(viii) to a(xii).

Observations

Follow the observation table as dealt with in testing of wiring installation.

Precautions

(i) Carefully consider the dimensions while marking the layout.

(ii) Never over or under thread the conduit ends.

(iii) See that the distance between two saddles does not exceed one metre.

(iv) Saddle the conduit lengths within 5 cms from terminations.

(v) Leave some length of P.V.C. wires inside the conduit junction boxes.

(vi) See that no necked portion of the conductor remains outside the terminal holes of the wiring accessories.

(vii) Test the wiring installation and check for correct circuit before energizing with the supply mains.

(viii) Apply mobil oil while threading the conduits.

(ix) While adjusting the conduit die, take care of the thickness of the conduit and the depth of thread required.

(x) See that the chasings are well plastered and that inspection covers of conduit accessories are accessible.

Questions for Evaluation

(i) Where is the conduit wiring installation preferred?

(ii) Why is earthing most essential in the threading part of conduits?

(iii) What do you understand by the earth continuity test?

(iv) What is the maximum permissible distance between two saddles?

(v) What specific precautions are observed in the concealed conduit wiring system?

(vi) What precautions would you observe while threading a conduit?

Experiment No. 3

Title of Experiment

To prepare a distribution/service connection board.

Specific Objectives

(i) To understand clearly how the electric supply is connected.

(ii) To know the order in which various components of the circuits are connected.

(iii) To know where possible checks can be made in the case of supply failure or electrical breakdown.

(iv) To wire up a typical distribution board.

Introductory Information and Related Theory

Domestic supply, normally single phase, is connected directly to the energy metre without any fuse or isolation device. The phase and neutral are connected at the supply input terminals i.e. on the left hand side. The output from the energy meter, from the right hand terminals, is connected to the main switch, the phase though a mains safety fuse and neutral directly.

The earth is connected to the body of the energy meter, the sheet steel meter-board, the body and cover of the safety fuse, the main switch, the distribution fuse box body and distribution board, the conduit wiring and all earthing terminals on the electric supply sockets. This common earth is, in turn, connected to the main earth at the supply input points.

The main switch has internal fuses and its output is connected inside the distribution fuse box directly, and this is distributed to the various rooms.

But if the energy meter and distribution box are at different locations, as in a multi-storey complex, then the output from the main switch is routed up to the distribution box, or through two main switches, one for light circuit and one for power circuit, to their respective distribution boxes.

Equipment and Materials

Iron clad single phase D.P. on/off switch, switchboard distribution board, distribution fuse box, flexible

conduit, screwdrivers, pliers, cable drill, electric drill, bits set, screws, ends, earthing wire, hammer, hand cleats.

Circuit Diagram

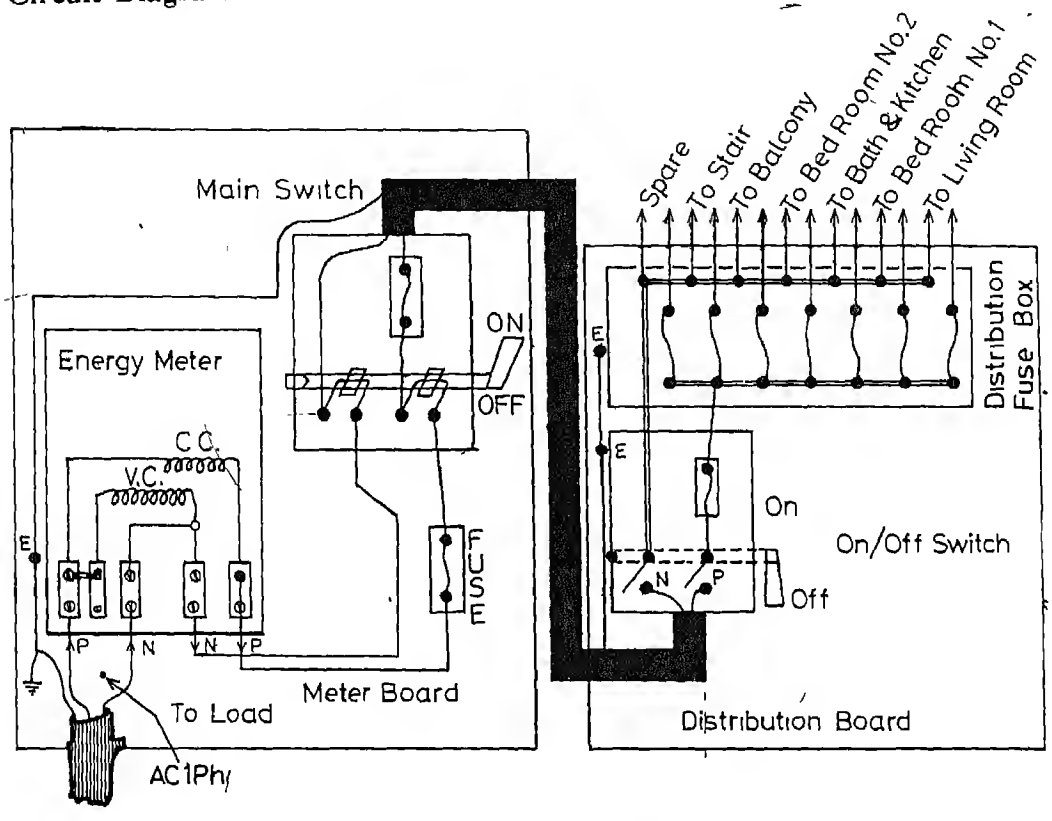

Fig. 3.1 Wiring of a Distribution Board to Different Points.

Procedure

(i) Take the distribution box, position the components, mark their position, drill and tap. Mount the components.

(ii) Carry out the wiring and check for continuity and insulation. Earth all the components and check. Make a record of all the tests in a tabular form.

Tabular Record

Test	*Reading*	*Result*
Mechanical checks	Carried out	o.k.
Continuity test	Carried out	o.k.
Insulation test	Carried out	o.k.
Earthing	Carried out	o.k.

Precautions

(i) Don't attempt any repair on the energy meter connection cover and main fuse cover. They are sealed by the electric supply authority.

(ii) Always switch off the main switch in case of any accidental fire or burning of the electrical circuit.

Questions for Evaluation

(i) What is the control in the phase connection before connections to the energy meter?

(ii) What is the purpose of putting a fuse in the phase before the main on/off switch?

(iii) Why is the earthing of all the mettalic bodies of switches, boxes and meter boards connected to the main earth of the supply agency?

References

Same as for experiment No. 2.

Experiment No. 4

Title of Experiment

Testing of domestic wiring installations.

Specific Objectives

To ensure safety, and satisfactory, trouble free working and longer life, testing of domestic installations is considered most essential on the following occasions:

(i) Before putting a new installation in service and connection of supply mains.

(ii) Whenever a change, addition or modification in the existing wiring is done.

(iii) Periodical testing ot existing wiring.

Introductory Information and Related Theory

The following tests are carried out on the installations initially and at regular intervals, and a record is maintained or a certificate is given.

(i) Continuity test of the electrical circuits.

(ii) Polarity checking of all single pole switches and 3-pin sockets.

(iii) Insulation test.

(iv) Earth continuity test.

Test Equipment and Tools

A continuity tester or a low voltage source with suitable indicating system, ohm-meter, megger/insulation resistance tester, pliers combination, screwdrivers.

Circuit Diagram

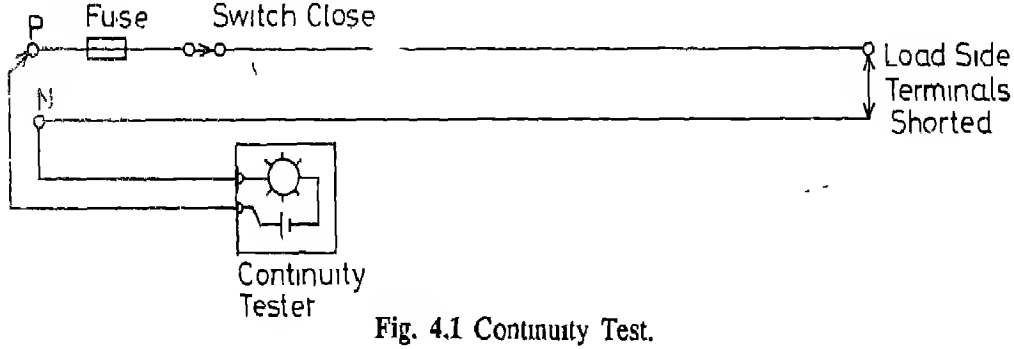

Fig. 4.1 Continuity Test.

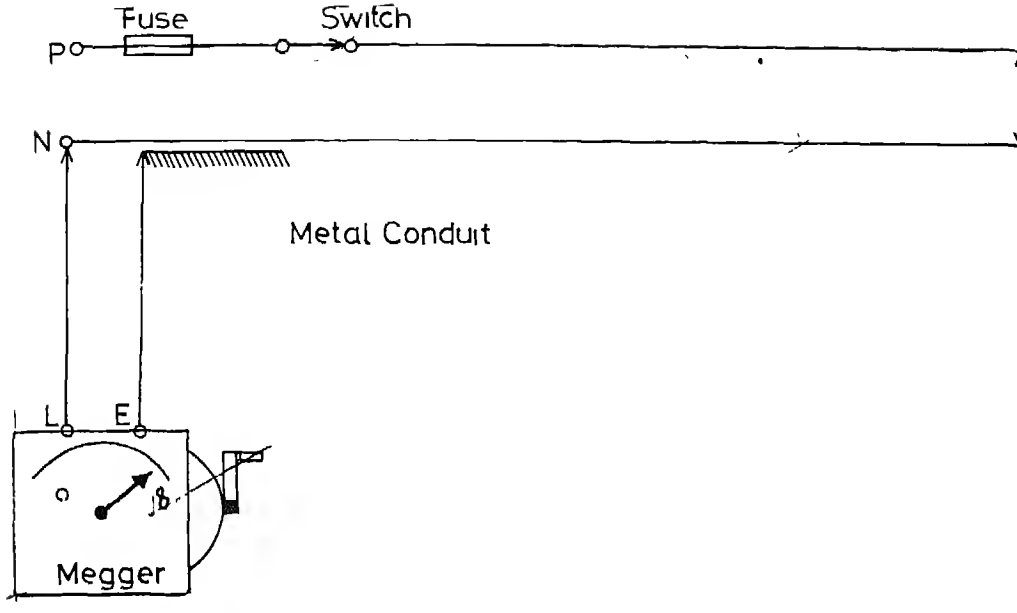

Fig. 4.2 Insulation Test of Circuit to Earth (Conduit).

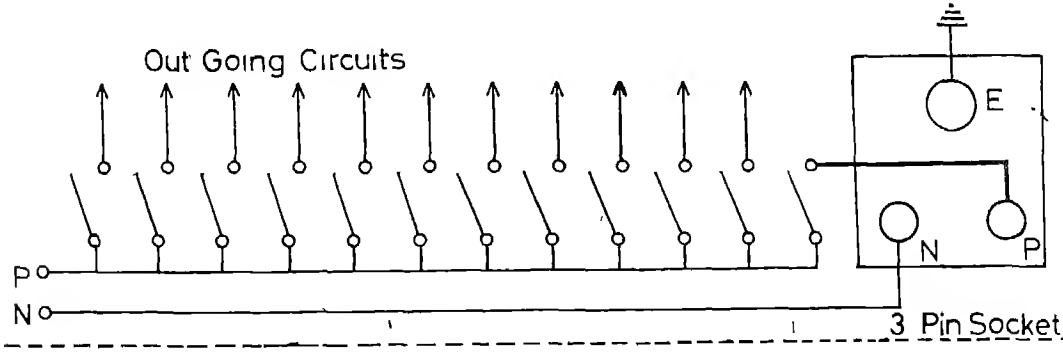

Fig. 4.3 Testing of Polarity of Switches and 3-pin Socket.

Procedure

(i) Disconnect the supply from the existing installation and remove the main switch fuses.

(ii) Disconnect all loads like fans, lamps, tube lights, stabilisers, electric bell, buzzer, heaters, ovens, geyser, etc., if already connected

(iii) Place all the fuses in the distribution fuse box, close the switches. Short the load points and three-pin sockets.

A. *Continuity Test*

Check one circuit at a time from the output of the respective fuse to the neutral strip with a continuity tester; after removing the fuse, note the indication. A lighted lamp or deflection on the instrument shows "continuity", and no indication shows, open circuit or high resistance joint Record the results of each circuit. Replace each fuse after the test. See Fig. 4.1.

B. *Testing for Polarity of Single Pole Switches and Sockets*

(i) Open all the switchboards and check that all switches control the phase line. Fig. 4.3.

(ii) Check that all 3-pin sockets have the phase on the right hand side pin at the base facing the socket and is controlled by a switch. Close all the switchboards.

C. *Insulation Resistance Test*

Insulation resistance is carried out by using a 500 V megger or insulation resistance tester.

Before checking, test the instrument for correct indication:

(i) Short the output leads and rotate the handle. The pointer should deflect to zero on the scale

(ii) Keep the leads open, and rotate the handle. The pointer must stay at infinity point on the scale.

(iii) Connect the tester's 'line' terminal to the output of the main switch and the earth terminal to the earth of the switch casing. Rotate handle and note the reading.

(iv) Pointer showing infinity or close to this point on the scale shows good insulation.

(v) Pointer showing zero or close to it indicates poor insulation. Record each reading.

(vi) Remove the load shorting link and check between phase and neutral lines. Record the reading.

(vii) Check phase line to earth and record the reading

(viii) Check neutral to earth and record the reading.

D. *Earthing*

To ensure continuity in earthing, all the metallic conduits, iron boxes, iron clad switchboards, earthing points on various light and power sockets must be continuous electrically to the main earth and must not have a resistance value more than 1 ohm when checked with an ohm-meter.

Record of Observations

S No	*Test*	*Read-ing*	*Obser-vation*	*Result*
1	2	3	4	5
1.	Continuity Test			
2	Insulation Test			
	i) Conductors to earth with load terminals shorted			
	ii) Phase to neutral — Lead			
	iii) Phase to earth — Terminals			
	iv) Neutral to earth — Open			
3.	Polarity Test			
4.	Earth Continuity Test			

Precautions

(i) Always disconnect the supply before attempting any test.
(ii) Always check the megger before use.
(iii) Bring the circuit to normal working conditions after testing.
(iv) Always record the results.

Questions for Evaluation

(i) Why is testing essential on domestic electrical installations?
(ii) What purpose is served by maintaining a record of test results?
(iii) What may happen if the insulation tester is not checked before carrying out the insulation test?
(iv) Why is it essential to disconnect the supply from the installation before testing it?

Experiment No. 5

Title of Experiment

To study the possible faults in domestic wiring, to locate them, and to rectify them.

Specific Objectives

(i) To understand the functioning of an electric circuit.

(ii) To establish a clear concept of three essentials of the circuit i.e. source, circuit elements, and the connected load.

(iii) To analyse the faults with reasoning, locate them and to carry out rectification.

Introductory Information and Related Theory

Every electrical circuit needs four essential elements for proper functioning i.e.

(i) Energy source.

(ii) Control components like switches, fuses, circuits breaker, etc.

(iii) Wiring

(iv) Equipment, i.e. lamp, fan, iron, cooler, heater, etc.

Most of the common faults occur as a result of supply failure, defective switches, sockets and plugs, faults in the wires, or defective equipment, and an electrician must understand clearly the reported fault, reason it out and try to locate it from the simplest possibility.

Equipment, Tools and Instruments

Insulated combination pliers, set of common screwdrivers, test lamp, neon tester, fuse wires 5 amp and 10 amps, insulation tape — PVC self adhesive, or black cotton self adhesive, knife, (multimeter, megger and continuity tester are optional).

Circuit Diagram

Nil

Procedure

(1) Note down, the details of the building, flat, house and room number, if applicable and write down the fault with its associated circuit such as "Light is not working in room No. 114" or "There is no power in the basement" or "Cooler pump motor in physics lab. cooler

unserviceable'' or ''Complete black out in the projection room'', etc.

(ii) Take one fault at a time and start the work; try to complete it before attempting the second one. But if more than one faults occurs at a time, then attend to them in order of priority, i.e. the most important first and the less important last. Try to collect other information related to the faults which can be helpful to localise and rectify the defect quickly. For easy understanding, let us take a few typical cases.

A. *No light in a particular building*

Check up if other buildings in the adjoining area have light. If other building also do not have light, then possibly the phase feeding the building is off, or a pole fuse or feeder pillar fuse is blown. Report to the nearest supply agency and do not attempt any repair.

If all other buildings have light, then check up the main fuse in the main switch after switching it off.

(i) Replace the blown fuse with a proper fuse wire.

(ii) Check the supply at the mains switch with a neon tester and test lamp. If it is alll right, fix the rewired fuse in position.

(iii) Switch on all loads in the building.

B. *If the fuse blows out again after switching on the main switch and other circuits, then proceede as under*:

(i) Do not replace the fuse with a thick wire, but locate and rectify the defective circuit.

(ii) Remove all the fuses from the distribution board, switch off the circuit switches, and check across each fuse with a series lamp i.e. test lamp.

(iii) If the lamp lights on a particular fuse, it shows fault in that circuit before the switch i.e. the conductor is earthed to the conduit or shorted with neutral wire or both. If rectification is not easily possible, then isolate that circuit, replace the fuses in the other circuits and switch on. This fault can be grouped under major rectification.

C. *In a room, only one light is defective and others are glowing bright*

	Possible faults	*Rectification*
(i)	Fused lamp	Check lamp and replace
(ii)	Lamp loose in holder	Check and replace defective lamp holder
(iii)	Loose connection at switch terminals	Tighten the connection at the switch terminals
(iv)	Loose fuse in holder, blown out fuse	Check fuse, tighten connection and replace the fuse
(v)	Loose connection at fuse holder	Check and tighten the fuse holder connections

D. *Lights are working but desert cooler/airconditioner does not work*

	Possible Faults	*Rectification*
(i)	Blown out fuse	Check and replace the fuse

(ii)	Loose connection at the rear of the 3-pin socket	Check and tighten connections
(iii)	Loose connection at the plug pins	Open and check the connections in the plug and tighten the connections, if required
(iv)	Over heated socket, oxidized and burnt out pins	Replace with a serviceable socket
(v)	Low voltage	If the lights also glow dim, measure the voltage, switch off and wait till voltage improves or use a voltage regulator

E. *In a particular room, no light works, but when checked, all switches show phase available.* When checked with a test lamp, the lamp doesn't light from the switches to the neutral wire, but lights to earth.
Possible Fault: Open neutral
Rectification: Check and ensure neutral return.

SOME COMMON WIRING FAULTS IN TABULAR FORM

S.No	*Fault*	*Possible Causes*	*Rectification*
1	2	3	4
1.	No light	1. Fused filament lamp	1. Check and replace with a serviceable lamp
		2. Blown out fuse	2. Check the fuse and replace after re-wiring
		3. Defective switch/loose connections	3. Check and replace or tighten connections
		4. Fractured aluminium wire at the connection points in holder or switch	4. Renew connection if fractured
		5. Loose lamp holder	5. Replace with a serviceable holder
		6. No power	6. Check for power of mains fuse, if blown, and replace
2.	Fuse blows out after replacement	1. Excessive load than planned or low capacity fuse	1. Check up the connected load and remove extra load, if connected, or put the proper fuse
		2. Short circuit in the equipment	2. Switch off and check each item for earthing and rectify the fault

		3 Short circuit exists even after disconnection of the equipment	3. Switch off all load switches and check
		4. Short circuit exists even with all the switches in the off position	4. Fault exists before the switches, locate and isolate the defective circuit
		5. Short circuit is due to phase wire short to neutral inside the conduit	5. Pull out the defective wire and drew through new wires and connect after checking
3.	Lights flicker when heater is switched on	1. Loose fuse grip in holder in main fuse	1 Check and replace heating up fuse grip or main switch, tighten points in the holder
		2. Loose contacts in the main switch knife contacts	2. Check for sparking, heating up of fuse grip or main switch, tighten contact points, clean burn out surface and ensure the tightness of connections
		3. Loose connection of aluminium conductors in the main circuit before distribution	
4.	Water pipes give shock	1 Leakage in wiring	1. Check insulation of wiring using a megger, if weak, replace the defective wire
		2. Open neutral	2. Check continuity of neutral wire
		3. Leaking, geyser, oven, refrigerator and improper or broken earth return	3. Check all appliances for insulation and proper earth return and rectify the fault

Precautions

(i) Always switch off mains before testing a circuit or attempting any repair on the installation.

(ii) Use rubber soled shoes and rubber gloves as far as possible while working on electrical installations.

(iii) Use tools with insulated handles.

(iv) While checking with a test lamp, connect one lead first to earth or neutral and then only connect the second lead to the live terminal to prevent accidental shock.

Questions and Evaluation

(i) Why do the power sockets get burnt?

(ii) Why is it essential to earth all the domestic electrical appliances?

(iii) What is the purpose of a fuse?

Experiment No. 6

Title of Experiment

Testing and repairing of an electric soldering iron.

Specific Objectives

After the completion of this practical exercise, the trainee should be able to:

(i) know the different parts of a soldering iron.

(ii) repair the soldering iron and replace the heating element.

Introductory Information and Related Theory

One of the most essential tools required for doing any electrical repairs is the electric soldering iron. This is used for making the permanent connections i.e. soldering the joints or conductor ends with the terminals etc. This essentially consists of a heating element (which may sometimes be a sealed unit) for suitable wattage made out of nichrome wire/ribbon wound on mica strips placed inside a metallic tube having a copper bit at one end and wooden/bakelite handle at the other. There is a terminal housing on the extreme end of the handle. The wires making connections between the heater element and terminals are also placed inside the metal tube. A connecting cord connects the terminals in the bakelite housing The ratings of the soldering iron i e. working voltage, wattage, manufacturer's name, etc are cast-embossed on the cover of the terminal housing.

In short, soldering irons also work on the principle of heating effects of electric current.

Equipment and Materials

(i) Soldering irons of different shapes, sizes and wattage.

(ii) Heating elements of different size, shapes, voltage and wattage.

(iii) Porcelain beads.

(iv) Mica pieces.

(v) Multimeter/AVO meter.

(vi) Test lamp.

(vii) Insulated combination pliers 15 cms.

(viii) Screwdrivers 15 cms, 10 cms

(ix) Flat file 25 cms, smooth.

(x) Screwdrivers 15 cms, 10 cms, philips type.
(xi) Soldering paste.
(xii) Resin-cored soldering wire.
(xiii) Electrician's knife.
(xiv) Three-pin plug top 250 V, 5 amps.
(xv) Three-core workshop flexible wire 660 V grade, suitable for 5 amps/16 amps.
(xvi) Emery paper No. 00.

Circuit Diagram

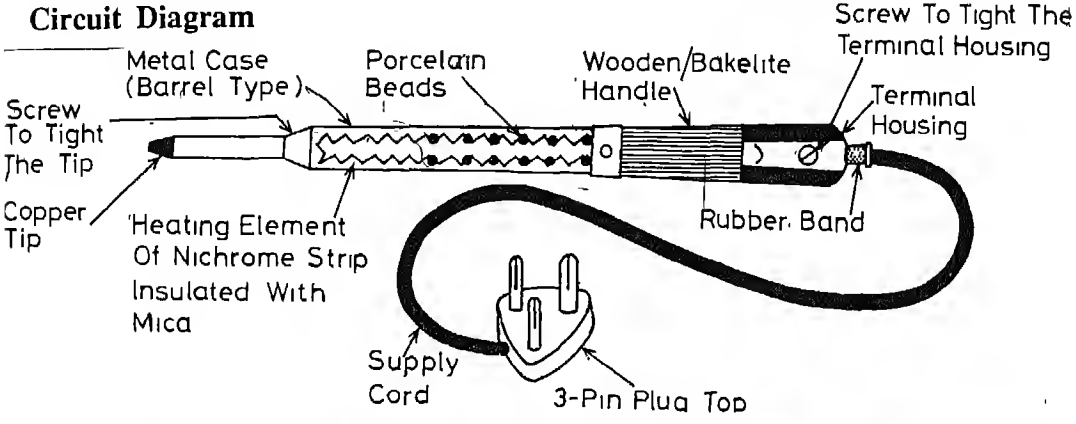

Fig. 6.1 Different Parts of Soldering Iron.

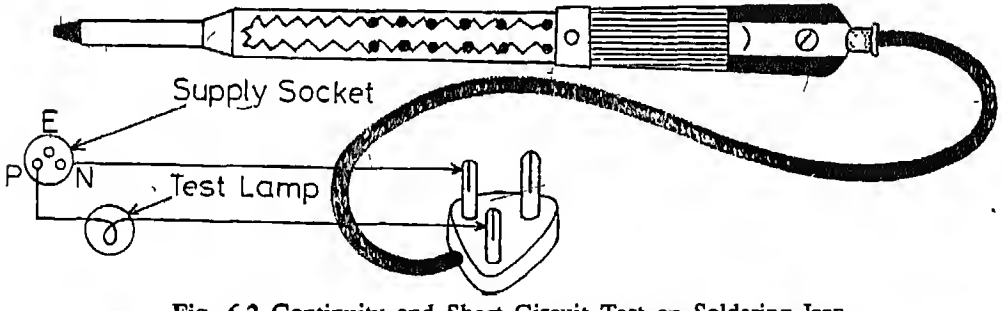

Fig. 6.2 Continuity and Short Circuit Test on Soldering Iron.

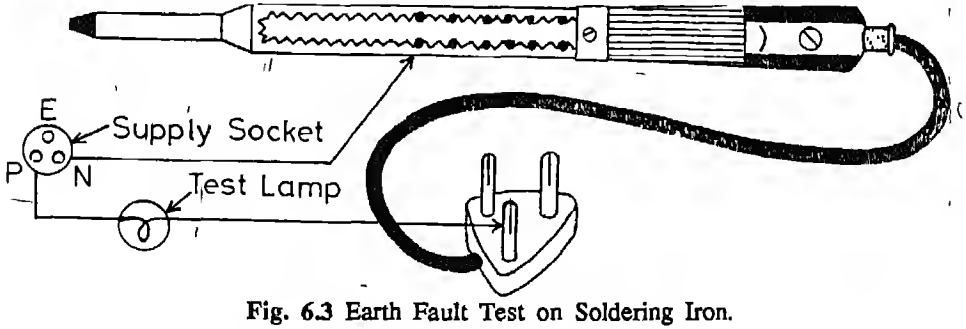

Fig. 6.3 Earth Fault Test on Soldering Iron.

Procedure

A. If the soldering iron does not heat up, it may be either due to failure of electric supply or open fault in the circuit. To locate this fault:

(i) Check the supply in the wall socket.

(ii) Check for the proper tight connections in the terminal housing and in the plug top.

(iii) Check the continuity of the core conductors by a test lamp/multimeters/AVO meter after disconnecting it from the terminal housing. If it is OK up to the terminal housing, it means open circuit lies inside the soldering iron.

(iv) If the heating element is a sealed unit, replace it.

(v) Otherwise, open out the terminal housing and handle.

(vi) Take out the heating element and check at the joints. If found loose, tighten them.

(vii) If there is an open circuit in the element itself, replace it.

(viii) Reassemble the soldering iron and connect the cord.

(ix) Check for continuity from the plug top, first with series test lamp and then by connecting with the supply mains.

B. When a soldering iron, connected with the supply mains, either blows a fuse or trips off the circuit, it is a clear indication of the short circuit in the soldering irons circuit. To trace this fault.

(i) Re-check the complete circuit for continuity either by a test lamp or multimeter/AVO meter.

(a) While testing with the series test lamp, if it glows bright, it is an indication of a short circuit.

(b) While measuring the resistance with a multimeter/AVO meter, if it indicates 'Zero' or nearer value i.e. much less than the value of the resistance of the heating element, it means there is a short circuit.

(ii) Check and see whether any of the live wires have opened and come in contact with the other wires or earth wire/terminal in the plug top or terminal housing. If so, eliminate the fault and re-tighten with appropriate terminal.

(iii) Disconnect the connecting cord from the terminal housing of the soldering iron and check with test lamp/multimeter/AVO meter for "No Continuity" between any of the two cores of the cord.

(iv) If still no fault has been traced, it means the fault is in the heating element. Take it out and see if there are any broken beads or mica strips damaged, resulting in the short circuit between the strands of the element.

(v) If so, select the heating element of appropriate shape, type, size, voltage and wattage ratings and replace.

C. If a soldering iron gives shock, it means there is an earth fault. Check the soldering iron by the test lamp by connecting one of the test leads with any one of the terminals and the other to the earth terminal of the plug top. If the lamp glows, it indicates the earth fault in the circuit. To locate this:

(i) Repeat steps B(i) to B(v).

(ii) If required, check the heating element and see if any of its portions has come in contact with the metallic portion of the body due to improper placement or defective beads or breaking of mica. Isolate the contact by replacing mica or bead.

(iii) Clean the bit with emery paper, or if required, with a smooth flat file when found oxidized.

(iv) Test the soldering iron by connecting it with the supply mains and when it is hot, apply soldering flux on the side of the copper bit and then solder till it gets tinned. This is done to prevent oxidation and better soldering.

(v) Repeat the previous step for tinning the other side of the copper bit also.

Tabular Record of Observations

Continuity/Short Circuit Test

	Test Lamp Indication	*Multimeter reading*
Open circuit	No light	Infinity
Short circuit	Bright	Zero
Perfect	Dim	Indicates value of resistance

Earth Fault Test

Earth fault	*Test Lamp*	*Multimeter indication*
Yes	Glows	Zero
No	Off	Infinity or no indication

Precautions

(i) Before dismantling the soldering iron, first try to learn the cause of failure from outside.

(ii) Never patch any portion of the resistance of the heating element, when it is found burnt or broken. It must be replaced with a new one.

(iii) While assembling, ensure that no part of the conducting portion of the circuit comes in contact with any other portion or any part of the body.

(iv) If the heating element needs to be replaced, this should be done with a heating element of the correct voltage and wattage ratings, shape, type and dimensions.

(v) While taking out or placing in the heating element, see that it does not hit any of the metallic portions of the soldering iron.

(vi) If the cord is to be replaced, it should be of the proper type, length and ratings.

(vii) If the heating element is sealed in the tube of iron, never try to dismantle and repair it. It should be replaced.

Questions for Evaluation

(i) Why is it not desired to patch the heating element?

(ii) What points will you keep in mind while selecting a new element?

(iii) How would you check a soldering iron for continuity and short circuit?

(iv) Why is it necessary to tin the copper bit?

(v) How would you locate the short circuit in a soldering iron?

Reference

(i) *Study of Electrical Appliances and Devices* by K.D. Bhatia.

Experiment No. 7

Title of Experiment

Connections, testing and repair of an electric bell and buzzer.

Specific Objectives

(i) To understand the basic principle and operation of an electric bell and buzzer.

(ii) To become familiar with the constructional details of a bell and buzzer.

(iii) To become familiar with the more common wiring diagrams of bell and buzzer circuits.

(iv) To acquire the knowledge of testing and repairing of electric bells and buzzers.

Introductory Information and Related Theory

Most residential buildings are equipped with door bells to enable callers to make known their presence at the door. Also, in offices, hotels, hospitals and departmental stores, etc. bells are installed for convenience and necessity. Electric bells are used where a loud sound is required in places like residential houses, departmental stores and educational institutions. Buzzers are used in places like hospitals, hotels, offices, etc. where a mild buzzing is given to call an individual without disturbing others.

Electric bells/buzzers are constructed to meet different needs in their various applications. The single stroke is used where signalling is done with a code. The vibrating bell is used as a call bell. The combination bell serves a double purpose at the same time.

In its principle of operation, when the current is passed through a solenoid coil, a piece of iron is placed across a soft iron piece of solenoid, but when the current is switched off, the solenoid coil will be demagnetized and the piece of iron placed in it will be separated. The difference in the working of a bell and buzzer is that, in the case of a bell, the hammer or clapper strikes the gong, whereas in the case of a buzzer, the contact strip vibrates.

The constructional details are shown in Fig. 7.1 (a) and (b).

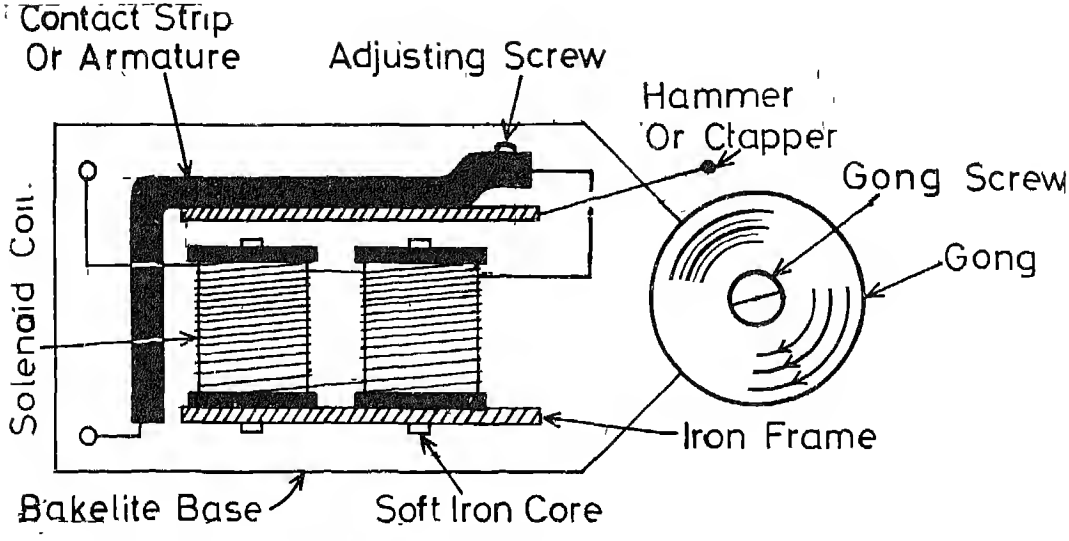

Fig. 7.1(a) Different Parts of Electric Bell.

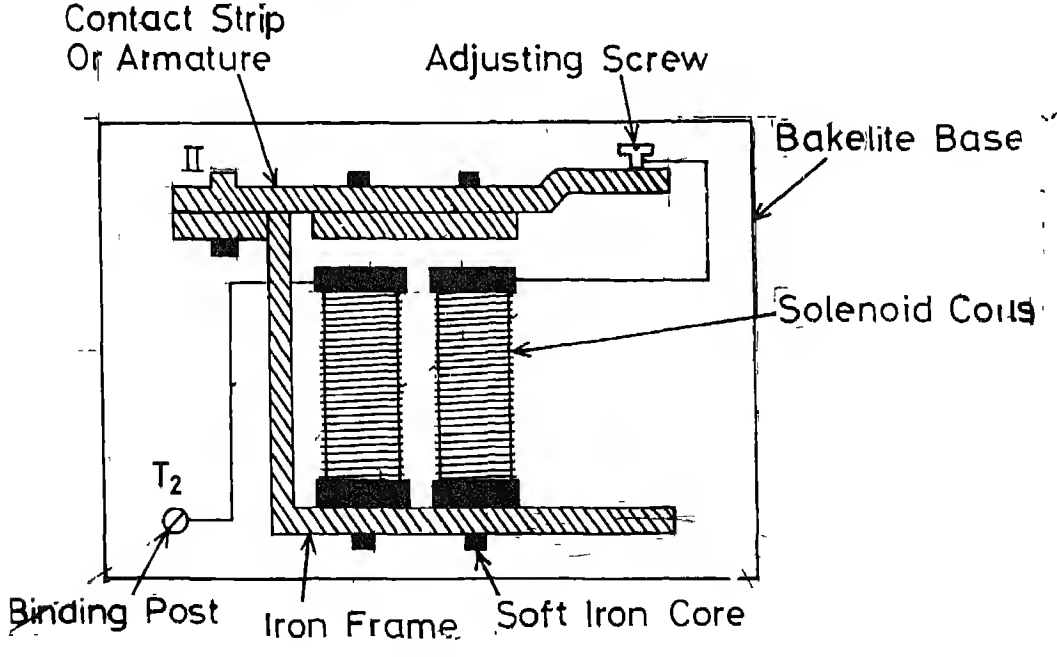

Fig. 7.1(b) Different Parts of Electric Bell.

Equipment and Materials

(i) Electric bell 1 No.
(ii) Electric buzzer 1 No.
(iii) Insulated combination pliers 150 mm 1 No.
(iv) Connected screwdriver 75mm 1 No.
(v) Insulated round nose pliers 150 mm 1 No.
(vi) Electrician's knife 1 No.
(vii) Test lamp (with 40 W lamp) with sufficient length of leads.
(viii) Smooth sand paper.

Circuit Diagram

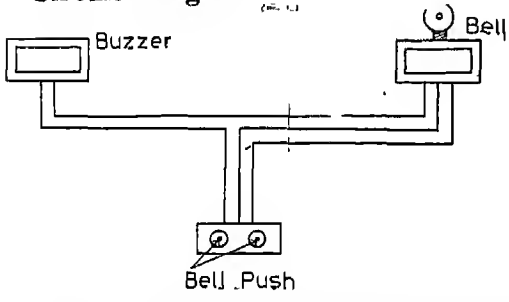

Fig. 7.1(c) Connection Diagram for a Buzzer and a Bell.

Procedure

(a) For Dismantling an Electric Bell
(i) Loosen the screws of the cover of the electric bell and separate it from the cover.
(ii) Disconnect the connections from the terminals.
(iii) Separate the screws.
(iv) Loosen the screws of the iron armature and separate them.
(v) Separate the armature strip rivetted with the clapper.
(vi) Loosen the screw of the gong and separate the gong.
(vii) Loosen the screws of the iron frames and separate them.
(viii) Separate the coils.
(b) Reassembling the Electric Bell
(i) Fix the soft iron cores in the iron frame and set the solenoid coils on them.
(ii) Fix the armature strip with the screw in the iron frame.
(iii) Adjust the adjusting screw by connecting one end of the solenoid coil to it.
(iv) Connect the other end of the solenoid coil to the terminal.
(v) Fix the gong with the screw in the base.
(vi) Place the cover in the base and tighten it with the screws.

Note: A similar procedure may be adopted in dismantling and reassembling an electric buzzer.

Testing and Repair of Electric Bell and Buzzer

The possible/probable faults in an electric bell or buzzer will be: (a) open circuit; (b) short circuit.

(a) *Open Circuit*: Breakage in the solenoid coils or disconnection of connected ends or broken ends from the terminals.
(b) *Short Circuit*: Solenoid coils may be burnt or the insulation of the winding wire scratched while fixing with a screwdriver, etc.

The other faults are improper adjustments of screws or burnt contact, the clapper may not strike the gong, low tension of the contact

strip or armature, rusted spot at the top of the soft iron core.

The open or short circuit in the bell or buzzer can be checked with a series test lamp by connecting the ends of the testing leads to the two terminals of the bell. If the lamp glows with full brilliance, it shows a short circuit. In the case of closed circuit, the lamp will give a dim light and there will be less sound from the bell or buzzer. Likewise, after testing, the defect can easily be removed.

Adjustments

In the case of open circuit, check the adjusting screw and if loose, adjust it. If there are any rusted points, clean, them with smooth sand paper. If the clapper is not striking the gong, bend it downward. Check the disconnected ends and connect them. Check the solenoid coils also for continuity. In case of short circuit, check the solenoid coils and if burnt, replace them with new coils. If the wire ends at the terminals are touching, separate them.

Precautions

(i) The solenoid coils should be connected in series.

(ii) Rusted spots should be cleaned with smooth sand paper.

(iii) Always test the given device in series with the supply to avoid the risk of short circuit.

(iv) Insulate yourself on dry wood or a rubber mat.

(v) Never give direct supply unless you are sure that there is no defect in the electric bell or buzzer.

Questions for Evaluation

(i) What is the basic principle of operation of an electric bell?

(ii) What is the difference between an electric bell and a buzzer?

(iii) What causes the vibrating bell to vibrate?

(iv) Name a place where it is of advantage to use a single stroke bell.

(v) Name the types of magnet windings used in bells.

References

(i) *Audel's Home Appliance and Service Guide* by Elwin P. Anderson.

(ii) *Fundamental Jobs in Electricity* by Perry and Salisfe Book.

Experiment No. 8

Title of Experiment

To design, fabricate and test a heating element.

Specific Objectives

(i) To know the design procedure of a heating element.

(ii) To know about the material employed for fabrication of a heating element.

(iii) To know the methodology of fabrication.

(iv) To know the method of testing.

Introductory Information and Related Theory

A pure resistance, when connected across A.C. supply, produces a current which is in phase with the supplied voltage. In the case of D.C. main, the current is direct, but it is difficult to achieve a pure resistance and some inductance is associated with it. However, the inductive effect is negligible and for all practical purposes, it may be considered as a pure resistance. The power dissipated in the element

$$= |V|I| = \frac{|V^2|}{R} \text{ a.c or } \frac{V^2}{R} \text{ d.c}$$

|V| = r.m.s. value of the voltage and V_{dc} is the magnitude of D.C. voltage. Now for a length and cross-section area with the material having specific resistance in ohm-m, the resistance is given by $\frac{\rho l}{a}$. Therefore, the power dissipated in the resistor is

$$\frac{V^2 a}{\rho l} \text{ watts or } \frac{V^2 a \times 10^{-3}}{\rho l} \text{ kw}$$

where a is in m^2 and l length in metres.

The heating element is a resistance of fixed length and known cross sectional area. The heating element is generally made of nichrome wire with provision for fitting into terminals. The heater plate is supported with a thick iron strip fitted with nuts and bolts. The ends of the element are insulated with porcelain leads. With provision for selection of different circuits in the heating element, low heat, medium heat and

high heat can be achieved. This is shown below:

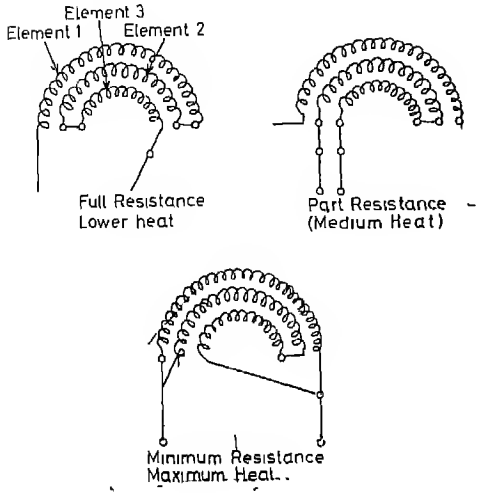

Fig. 8.1Location of Heating Element for Low, Medium and Maximum Heat.

The table given below illustrates the resistance, wire size in SWG and current carrying capacity for a given wattage of nichrome wire at 230 volts.

The element for any heating appliance can be designed having the following type of data.

(a) *Wattage*: The rating in watts for the resistance wire of a particular size.
(b) *Resistance*: The total resistance of the element in ohms or resistance per foot or cms.
(c) *Ampere*: Current capacity of the element in amperes.
(d) *Wire size*: The specific gauge of wire for the element.
(e) *Wire length*: The approximate total length of wire in feet or cms for the element.

S.No.	Wire size in SWG	Length in feet	Total resistance in ohms	Total amount in amps	Total wattage in watts
1	2	3	4	5	6
1.	33	38.3	494	0.435	100
2.	32	24.4	247	0.870	200
3.	31	16.9	100.37	1 300	300
4.	29	24.2	123.52	1.730	400
5.	27	30.6	98.82	2.170	500
6.	26	32.0	82.35	2.60	600
7.	25	34.8	70.58	3.04	700
8.	25	30.7	61.7	3.48	800
9.	24	34.2	54.[illegible]	3.90	900
10.	23	38.6	52 90	4.35	1000
11.	23	35.0	44.92	4.80	1100
12.	22	38.0	41.17	5.52	1200
13.	21	47.5	38.00	5.65	1300
14	20	55.7	35.30	6.10	1400
15.	19	66.0	32.94	6.54	1500

Equipment and Materials

(i) 10 m length of 23 No. SWG with resistance of 52.9 ohms and total current capacity 4.35 amps for a wattage of 1000 watts.

(ii) Single rod room heater as shown below:

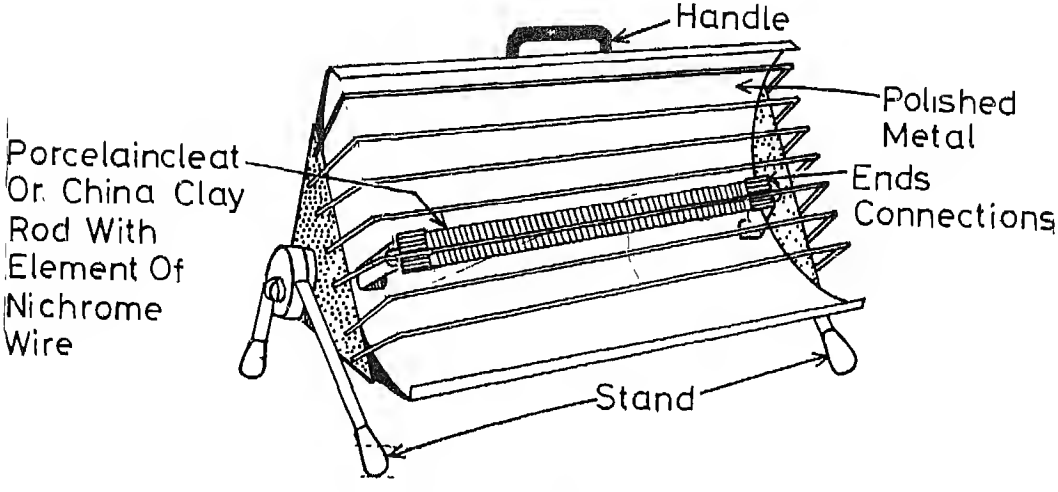

Fig. 8.2 Room Heater.

(iii) **Circuit Diagram**

The circuit diagrams are given below for testing

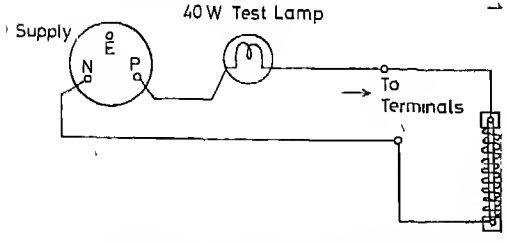

Fig. 8.3 Continuity, Open and Short Circuit Test on an Electric Heater.

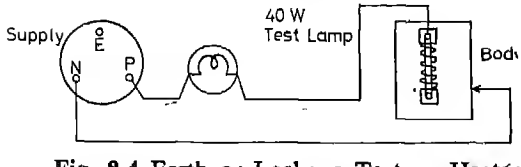

Fig. 8.4 Earth or Leakage Test on Heater.

Materials and Tools Required

Sl.No	*Name of the implement*	*Quantity*
(i)	Test lamp	1 No.
(ii)	Testing leads 3/22 SWG copper wire	2 No., 2m each
(iii)	Insulated combination pliers 15 cm	1 No.
(iv)	Insulated long nose pliers 15 cm	1 No.
(v)	Screwdriver 15 cm	1 No.

Procedure

Steps for design

Suppose we have to design an element for an electric stove of 1000 watts which is working on 230 volts mains, then the solution is to be obtained as follows.

Power to be consumed by electric stove = 1000 W

Total wattage of the supply = 230 V

Therefore, resistance of the element $= R = \frac{V^2}{P}$

$= \frac{230 \times 230}{1000}$

= 52.9 Ohm

Total current for the element $= \frac{230}{52.9}$

= 4.35 amps

Total length of resistance wire $= \frac{\text{Total R}}{\text{Ohms/per foot}}$

In this way, we will have to choose a suitable size of wire for carrying this current of 4.35 amps and having a resistance of 52.9 ohms. Then reference to the table can be made and the appropriate length may be worked out.

Fabrication

The single rod frame for room heater will be made available to you in laboratory. Choose a china clay rod which may be fitted in the terminals of the fire bar. The nichrome wire of appropriate length calculated by you should be procured from the market and then winding of this wire is made on the china clay rod and then connected to the terminals.

Testing

By connecting the two ends of the testing leads to the two terminals of the heater, if the lamp does not glow, it means there is an open circuit i.e. breakage in the element or disconnection of connecting wires or strips at the terminals. If the lamp gives bright light, it means there is a short circuit, i.e. both the connecting wires or strips inside at the terminals are touching. If the lamp glows dimly, then the heater element is correct. Now to perform the earth testing, connect one end of the testing leads to one terminal of the heater and another wire of the testing lead to the metal part of the heater. If the lamp glows, it means there is an earth fault, i.e. some part of the element or any connecting wire or strip is touching the metal part of the heater. If there is sparking on the body, it means there is leakage i.e. insulating material is leaking. The other faults may be in the cord or in the plug top or in the connector, i.e. breakage or disconnection of wire ends.

Tabular Records of Observations

(i) State the specification of a heating element.

(ii) Design steps (indicate only main calculation)

(iii) Conductor specifications

(iv) Fitting in the framework, check loose contacts, etc. and state the position.

(v)

	Lamp brightness	*Comment*
Open circuit test	—	
Short circuit test	—	
Earth leakage test	—	
Supply cord continuity check	—	

Precautions

(i) Obtain an appropriate conductor and check the steps of your calculations.

(ii) Avoid loose fittings of parts.
(iii) Insulate yourself on dry wood before testing.
(iv) Test the heater in series of the supply to avoid the risk of failure of supply.
(v) Never give direct supply unless you are sure that there is no fault in the heater to avoid the risk of failure of supply.

Questions for Evaluation

(i) Describe the principle of the working of a heating element.
(ii) If a number of heating elements are given to you, connect them in series, parallel and series parallel combinations to demonstrate various heating sinks (i.e. how low, medium and high heat can be obtained).
(iii) What material is used for a heating element?

Experiment No. 9

Title of Experiment

To study, test, dismantle and reassemble different types of heaters.

A. ELECTRIC STOVE

Specific Objectives

(i) To study an electric stove.
(ii) To dismantle an electric stove.
(iii) To reassemble an electric stove.
(iv) To test an electric stove.

Introductory Information and Related Theory

The basic principle involved in the stove is that when electricity passes through a resistor, it gets heated due to its I^2R losses.

In an electric heater or stove, a coiled heating filament made of nichrome wire is placed in the grooves of a porcelain insulator. The porcelain base is fixed in a metal frame. The ends of the heating element are brought to the porcelain connector by means of flexible leads covered over by porcelain beads.

The capacities of such stoves are 750 W, 1000 W, and 1500 W and they are used for cooking purposes. The disadvantage of this type is that the exposure of the heating element causes rapid oxidation when it is red hot and it presents a constant shock hazard.

Equipment and Materials

(i) Screwdriver
(ii) Cutting pliers
(iii) Spanner set
(iv) Series parallel testing board.

Procedure for Dismantling

Disconnect the connections of the element ends from the terminals of the heater. Loosen the nuts of the bolts and separate them. Separate the strip which holds the heater plate. Separate the heater plate from the heater frame and disconnect the element from the heater plate. Leave the rivetted parts of the heater as they are.

Reassembling

Place the element in the heater plate and tighten it with nuts, bolts and washers. Fix the heater plate with the strip by tightening it with bolts, nuts and washers. Use porcelain beads in the connected wires or connected strips and

tighten them to the terminals of the heater with nuts and washers. After complete fitting, test the heater with the series test lamp for open, short and earth fault.

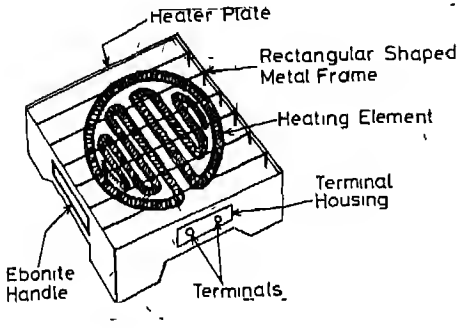

Fig. 9.1 Different Parts of Heater.

Testing

(i) Open circuit and short circuit test: By connecting the two ends of the testing leads to the two terminals of the heater, if the lamp does not glow, it means there is an open circuit. If the lamp glows brightly, it means there is a short circuit. If the lamp glow dimly, then the heater element is correct.

(ii) *Earth-Testing*

Test terminals are connected between one end of the coil and the metal part of the heater. If the lamp glows, it shows that grounding is present.

Precautions

(i) Before using a heater, one must be sure that its metallic body is completely earthed.

(ii) One must switch off the heater supply before putting any utensil on it or removing one from it.

(iii) Any liquid such as boiling curry, water, milk, etc. must not fall on the heater element as this will cause it to be fused.

(iv) While repairing a heater, we should disconnect it completely from the supply — switching off is not sufficient and we must take out the plug top also.

Troubleshooting Guide

S.No.	*Trouble*	*Cause*	*Remedy*
1	2	3	4
1.	1. Heater does not work	1. Fuse might have blown off	Remove short circuit of the heater. Replace the fuse.
		2. Open circuit in the heating element	Check the continuity of the heater element with a series lamp. If it is open, either connect it, or replace the heater element.

1	2	3	4
		3. Open circuit in the connecting lead	Rectify the trouble
		4. Short circuit in the heater	If the lamp glows fully when the series lamp is connected, it shows the short circuit. Remove the short circuit.
		5. Short in the lead wire	(i) Open the plug top of the lead, check it visually for short circuit, rectify the fault. (ii) Check the iron connector. (iii) Check the lead of the heater wire; if there is any short, rectify it.
2	Heater gives sparking intermittently	1. Due to loose connections	Tighten the nuts and bolts in the heater plate where the element is connected.
3.	Heater element gives out smoke	1. When boiling liquid such as milk, tea, etc. falls on the heating element it gives out smoke	1. Disconnect the heater from the supply. 2. Clean the grooves of the heater plates where liquid has fallen.
4.	Element gives less heat	1. The heater element is too long. 2. Due to low voltage.	Reduce its length according to specification. Complain to the supplier.

1	2	3	4
5.	Heater gives excessive heat	Length of the heater element is short due to many joints on repairing many times.	Replace with heater element of specified length.
6.	Heater gives heavy shock	1. Earth terminal may not be properly connected	Earth terminal is to be properly connected.
		2. Defect in the earthing system	Earthing system is to be checked and rectified.
		3. Heater element is grounded	Search for the point where grounding is taking place and rectify it.

B. HOT PLATE

Specific Objectives

(i) To study a hot plate.
(ii) To dismantle a hot plate.
(iii) To reassemble a hot plate.

Introductory Information and Related Theory

This is similar to an electric stove. It consists of a single unit element or twin unit elements. In a single unit hot plate, the element wire is placed in the grooves of a round cast iron plate and insulated with insulating material like fire clay, cement or plaster of paris which does not resist heat. The ends of the element are brought out of the plate, insulated with porcelain beads and connected to terminals in the terminals housing fixed in the middle portion of the metal body or plate. The base of the cast iron plate is covered with asbestos sheet and mica. The other parts of the single unit hot plate may be an iron ring (chromium plated) fixed under the ring and end cover which is also chromium plated. The hot plate is provided with ebonite handles on the sides and a tripod stand at the bottom to make it portable and convenient for use.

In the twin unit type plates, the heat of the element, is controlled by a heat selector switch which connects the heating element in different positions for (1) low heat; (2) medium heat; (3) high heat; and (4) off positions. The elements of hot plates are designed 1 to 2 Kw ratings.

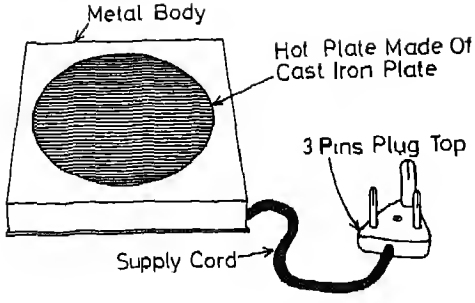

Fig. 9.2(a) Hot Plate.

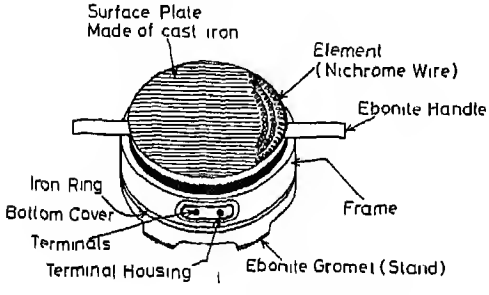

Fig. 9.2(b) Surface Plate.

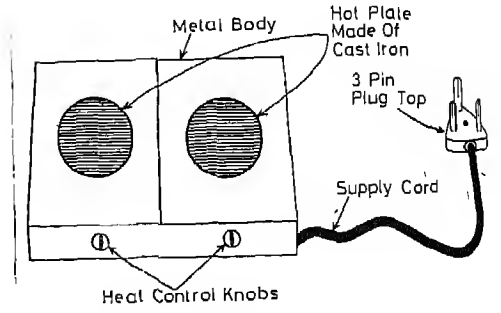

Fig. 9.2(c) Hot Plate (Twin Nos.).

Low Heat Position

In low heat position, the coils are connected in series as shown below:

Medium Heat Position

In this position, only one heater element remains connected with the supply.

High Heat Position

In this position, two coils are connected in parallel with the supply.

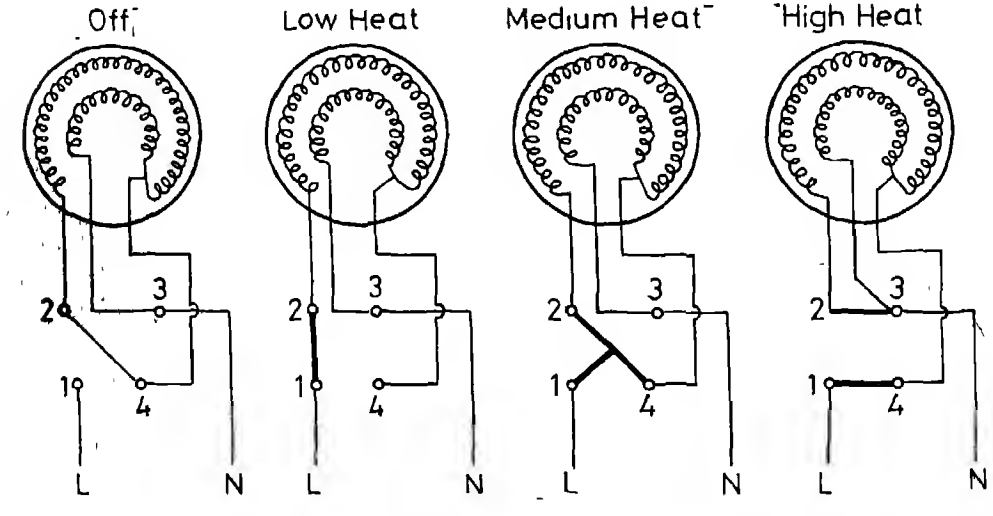

Fig. 9.3 Heater (with rotary control).

Equipment and Materials

(i) Hot plate.
(ii) Small screwdriver.
(iii) Cutting pliers (insulated).
(iv) Test lamp with testing leads.

Procedure for Dismantling

Separate the bottom cover by unscrewing the bolts and nuts. Disconnect the terminals of the element from the connector. Separate the iron ring by unscrewing the screws. Now the hot plate can be taken out of its position.

Reassembling

Place the hot plate over the frame and fix the iron ring by its screws. Connect the terminal of the element to the connector. During reassembling, the porcelain beads may replaced if they are broken. Fix the bottom plate with screws and nuts.

Testing

The open circuit, short circuit and earthing tests are to be conducted as in the case of the electric stove studied earlier.

Precautions

(i) During repair, the cord should be taken out of the connector.

Troubleshooting

The usual troubles in hot plates are open circuit faults, short circuit faults, earth faults and leakage faults. Refer to the troubleshooting guide of the electric stove.

C. ROOM HEATER

There are mainly two types of room heaters. They are: (a) rod type room heater and (b) bowl type room heater.

(a) Rod Type Room Heater

Specific Objectives

(i) To study the rod type room heater.
(ii) To dismantle the room heater.
(iii) To reassemble the room heater.
(iv) To test the room heater.

Introductory Information and Related Theory

The various parts of the room heater are: (i) Stand, (ii) Reflector (iii) Ends connector (iv) Rod (v) Element (vi) Connecting lead (vii) Switch.

The stand is made of M.S. sheet. The reflector is of rectangular, deep concave shape and it is chrome-plated to reflect more heat. The end connectors are made of copper or brass sheets. The end connectors house the china clay rod. The rod is made of an insulating material, generally china clay. It is fitted in the end connector. The element is made of nichrome wire and the element is wound on the china clay rod. The connecting lead used in the three types of heaters is the 3-core P.V.C. 40/0.0076 flexible cable. A 3-pin plug top is fitted with it. A room heater may be a single rod room heater or a two-rod room heater. A two-way switch is used for the two-rod room heater. If the two-rod room heater is used for 3 ranges then a rotary switch is provided. From this, four positions of the heater will be obtained and they are:

(i) Off position.
(ii) Low heat position.
(iii) Medium heat position.
(iv) High heat position.

The connections are similar to those

in the hot plate. The difference is that there are two rods in the room heater whereas there are two coils in the hot plate.

Room heaters are used to heat rooms in the winter seasons.

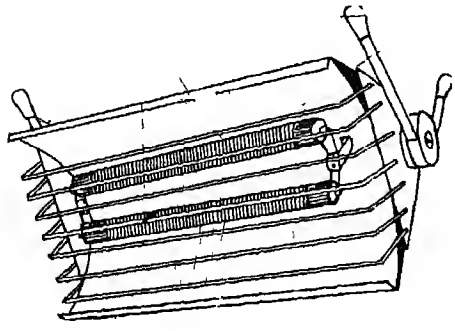

Fig. 9.4 Double Rod Heater.

Equipment and Materials

(i) Rod type room heater.
(ii) Connector.
(iii) Screwdriver.
(iv) Series parallel board, etc.

Procedure

For dismantling, open the back cover and take out the connection of the element from the terminal housing. The rod also can be opened from its end connectors.

While reassembling, connect the element with the terminal housing, after placing the rod with the elements, over the connectors. Close the back cover with the screws.

Testing

A room heater is to be tested for (i) open circuit, (ii) short circuit, (iii) earth fault and (iv) leakage faults.

Precautions

(i) The wires from the element should be properly connected to the terminal housing.
(ii) The end connecting wire is to be properly insulated with porcelain beads.

Troubleshooting Guide

S.No.	*Trouble*	*Causes*	*Remedy*
1	2	3	4
1.	Room heater is not working	1. Fuse might have blown off	Fuse is to be replaced. If the fuse of proper size is put on and even then the fuse blows off, rectify the short circuit point in the room heater, or the plug top cord.
		2. Due to the short circuit in the plug top, supply cord or in the room heater itself.	
		3. Element may be burnt	Replace the element with the rod.
		4. Due to the open circuit in the element.	Connect the broken ends.

1	2	3	4
2.	Room heater gives less heat	1 The reflector is defective	The reflector is to be replaced
		2 The voltage supply may be less.	Complain to the supplier
3.	Room heater gives shock.	Due to grounding.	Search for the grounding point inside the room heater and rectify the trouble.

There are some other faults that may occur in room heater:

(i) Fire rod may be broken; it is to be replaced.

(ii) Plug top or porcelain beads may be broken: get new ones and replace.

(b) Bowl Type Room Heater

Its body is made of thin sheet of mild steel. A china clay bowl is fitted in it. A coiled heater element of nichrome is fitted on the china clay bowl. A reflector is also fitted. The reflector helps to radiate more heat. This bowl is either of the screw type or the pin type.

The different parts of the bowl type heater are:

(i) Base stand
(ii) Reflector
(iii) China clay bowl
(iv) Guard
(v) Heater element
(vi) Cord with plug top

Equipment and Materials

Bowl type room heater, small screwdriver, insulated cutting pliers, series parallel testing boards, etc.

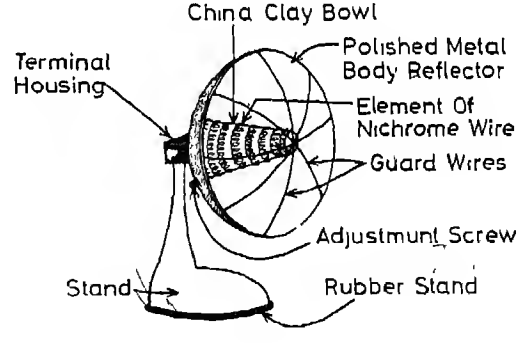

Fig. 9.5 Bowl Type Heater.

Procedure for Dismantling

The front guard is opened. Separate the element connections from the terminal housing. Separate the china clay bowl from the stand. The reflector can also be taken out.

Reassembling

Mount the china clay bowl on the stand and connect the wires to the element. Before that, the reflector is to be fixed. Then the guard is to be fixed.

Precautions

During reassembling, see that no live part is touching the body.

Troubleshooting

The same as for the rod type room heater.

Questions for Evaluation

Indicate the correct answer for the following statements, whether true or false, in the brackets against each:

(i) The heater base is made of porcelain. ( )

(ii) The heating element of an electric heater is of coiled coil. ( )

(iii) The heating element is made of copper wire. ( )

(iv) The maxium wattage of an electric heater is 1000 W. ( )

(v) The maximum length of a 100 W heating element is 45 cms. ( )

(vi) Normally an electric stove heating element is made of 26 SWG nichrome wire. ( )

(vii) The heating element omits less heat due to short length of heating element. ( )

(viii) Two types of room heaters, the bowl type and the rod type, are available. ( )

(ix) The base of a hot plate is made of fibre glass. ( )

(x) The selector switch used in the hot plates is convenient to control different heat ranges. ( )

References

(i) *Electrical Appliances (Theory and Repair)* by Anwani.

(ii) *Study of Electrical Appliances and Devices* by K.B. Bhatia.

(iii) *Electrical Appliances (Repair and Maintenance)* by K. Nath.

Experiment No. 10

Title of Experiment

To study, test dismantle and reassemble electric irons e.g. ordinary, automatic and steam irons.

Specific Objectives

(i) To know the various types of irons.
(ii) To know the various components of an iron.
(iii) To be conversant with the principle of utilisation of electric energy conversion into heat.
(iv) To test the various components of an iron.
(v) To reassemble the iron after the elimination of the fault.

Introductory Information and Related Theory

All electric irons used for hand pressing or ironing of clothing and other materials are equipped with a special resistance heating grid or element, whose resistance wire is designed to furnish the necessary heating required for the ironing process when properly connected to an electric circuit. The heating element in an electric iron consists of nichrome wire, which may be wound on special mica insulating sheet material or wound in a spiral and assembled on a protective metal tubing, properly insulated from the surrounding conducting surface. Electric irons, depending upon their construction, may conveniently be divided into three classes, namely:

(i) Non-automatic irons
(ii) Automatic irons
(iii) Steam irons

Non-automatic Irons

The non-automatic iron has no heat regulating feature, there being no thermostat to automatically control the heat, which means that when the iron gets too hot, it must be disconnected and allowed to cool. One type of non-automatic iron is equipped with a heat meter or "fabric heat indicator", the indicator pointing to the degree of heat that is safe for ironing the various types of fabrics.

Automatic Irons

These differ from the non-automatic type mainly in that they incorporate a

special heat-control device, or thermostat. The function of the thermostat is to regulate the heat to a specific predetermined value, thus, disconnecting the heating element when the iron becomes sufficiently hot, and reconnecting it to its source at a lower temperature. In this manner, the temperature of the iron will be held nearly constant, the actual temperature cycling back between certain set values. Most irons of this type are also equipped with a heat-control knob which regulates the heat between certain specified limits, depending upon the type of fabric being ironed, in addition to the foregoing features Other automatic irons are furnished with a special indicating light bulb usually fitted into the front of the operating handle.

Steam Irons

These differ from those previously described irons mainly in that they contain a steam chamber and water reservoir. Here the heat from the heating element raises the water temperature to boiling, causing steam to be emitted from a set of slots in the sole plate. In this manner, moisture-laden steam issues from the steam chamber in the iron through the slots in the sole plate.

Equipment and Materials

(i) 750 W, 230 V, non-automatic iron without temperature control.

(ii) 750 W, 230 V, automatic iron with heat control for a fixed temperature.

(iii) 750 W, 230 V, automatic iron with heat control for various temperatures according to the fabric.

(iv) Test board containing lamp, fuse, voltmeter, ammeter and switch, pilot lamp.

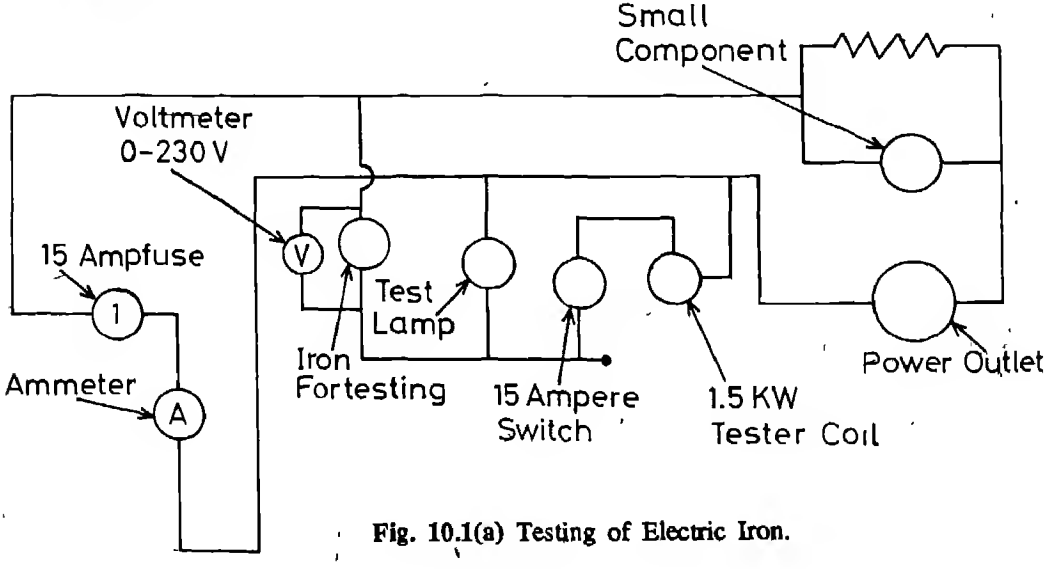

Fig. 10.1(a) Testing of Electric Iron.

Construction of an Iron

Study this diagram well. Because of constant use and abuse, irons always seem to need repairing.

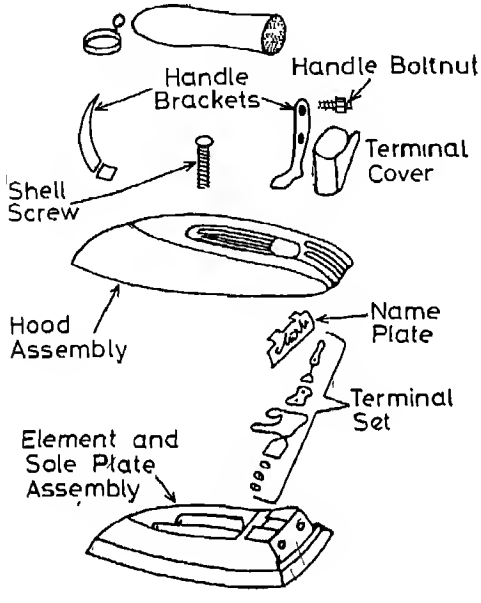

Fig. 10.1(b) Parts of Non-automatic Iron.

Procedure

(i) Study and check each component of the non-automatic iron shown in Fig. 10.1(b) and make a list of components.

(ii) Put it on the test panel and note the voltage, current drawn from the supply. If the lamp is half bright, the iron is all right. If voltage across the lamp is very low, there is a chance of short circuit in the iron. If the current is zero or very small, there seems to be some discontinuity or open circuit.

(iii) *Disassembling*

Though the method of disassembling a conventional iron varies with different makes and models, two or three methods are common. Generally, the following procedure is adopted.

Remove the terminal-enclosure cap, disconnect the cord set, remove the control knob, take out the cover screws and lift off the cover and handle assembly as a unit.

On other models, remove the cover plate to expose four screw heads. Loosen the two inside screws and remove the two outside screws in the heel cavity and slide the handle toward the back of the iron to remove the handle and cord set as a unit, thereby allowing access to the cover screws.

On some other models, remove the terminal enclosure cap, disconnect the cord set and then remove the handle base to gain access to the cover screws. A careful examination of the iron will usually reveal the logical method of disassembly.

When you remove the controllers situated over a chromium plated or other type of finished surface, slip a piece of soft cardboard between the surface and the shank of the tool to avoid damaging the finish.

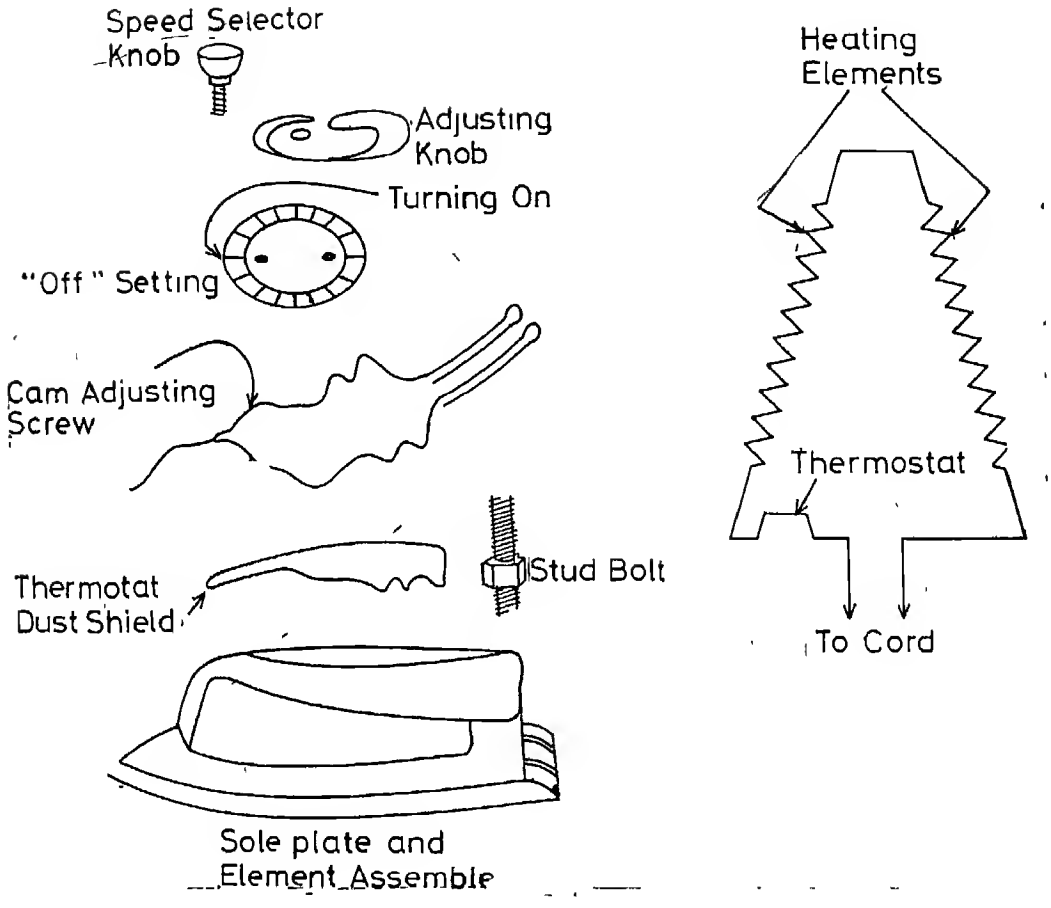

Fig. 10.1(c) Parts of Automatic Iron with Heat Control.

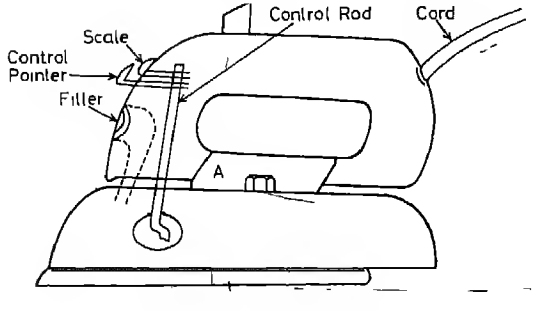

Fig. 10.1(d) Steam Iron.

(iv) *Reassembling*

Reassembling the components in the reverse order of dismantling and check that each component has been fitted properly. The reassembling is to be done only after each component has been checked and tested.

Tabular Record of Observations

Sl No	*Name of Component*	*Test Result*	*Replacement or no Replacement*
Example 1.	Heating Element	Faulty	Replace with a proper element

Precautions

(i) Test the cord set employing an appropriate testing procedure If the cord set has a fault, attach a test cord and continue.

(ii) Assuming that the iron has a good cord set, open the tester coil switch and connect the iron to the series test receptacle and turn the control knob on the iron to its highest temperature. If the lamp does not light, an open circuit is indicated in the iron and you must test the element and thermostat separately.

(iii) Close the tester coil switch. If the lamp does not dim to about half its normal brilliance, a short circuit is indicated within the iron and the element and thermostat must be tested separately.

(iv) Revolve the control knob from one extreme to the other, observing whether or not the test lamp stays half bright through all the on stages and goes off at the off point.

(v) Transfer the polarity of the circuit by reversing the attachment plug in the series test receptacle and again revolve the control knob from one extreme to the other. During this step, watch the ground indicating lamp on the tester to be certain that it stays out. If it lights up, a ground is indicated and the fault must be located and corrected before proceeding further.

(vi) The iron is now ready for the final test, provided the preceding tests have established that there is a closed circuit in the iron, but no short circuits, loose connections, or ground.

(vii) Disconnect the iron from the series test and connect it to the power outlet which has been equipped with a pilot lamp. Set the control knob at 'Rayon' and allow the iron to heat while you are beginning the next step.

(viii) Do not move the control knob to the next higher stage until the iron has shut off and come on automatically at least once.

(ix) Repeat it for 'wool', 'cotton' and 'linen' in exactly the same manner.

Questions for Evaluation

(i) What are the various components of an automatic electric iron?

(ii) In what way is a steam iron different from a non-automatic elec-

tric iron?

(iii) What basic steps are involved in testing a faulty iron?

(iv) On what principle is an electric iron made?

(v) What is the basic function of a thermostat? How does it regulate diffetent temperatures for different fabrics

(vi) What are the basic steps for repairing a faulty iron?

References

(i) *Small Appliance Servicing* by P.T. Brockwell, Jr.

(ii) *Audels Home Appliance Service Guide*, Edwin P. Anderson, Theoaudel & Co. Publishers, New York, U.S.A.

(iii) *How to Repair Small Appliances*, Jack Darr, Howard W Sams & Co. Inc., The Bobbs-Merrill Company Inc., New York.

Experiment No. 11

Title of Experiment

To study, test, dismantle and reassemble electric toasters, e.g. non-automatic, semi-automatic and automatic types.

Specific Objectives

After the completion of this practical exercise, the students should be able to:

(i) Test the different types of toasters e.g. (a) non-automatic; (b) semi-automatic; (c) automatic and their various components.

(ii) Dismantle, repair/replace the defective components and reassemble the toaster.

Introductory Information and Related Theory

One of the most popular household electrical appliances is the toaster which is used for toasting bread. This works on the principle of "heating effects of electric current" i.e. when the current is passed through any resistance, heat is produced which is proportional to the square of the magnitude of current passing through the resistance, the amount of resistance through which current is passed and the time i.e. I^2Rt.

Toasters essentially consist of a heating element made of nichrome ribbons/wires wound on mica strips, and line cord attached to the elements. Generally, electric toasters are of three types:

(i) *Non-automatic*

In the non-automatic toasters, the bread is placed on hinged racks, one or two slices on each side of the open heating element, and after the bread is toasted on one side, it is reversed. After both sides are toasted, it is removed and the toaster switched off.

(ii) *Semi-automatic*

Semi-automatic toasters, apart from the heating elements, are incorporated with some signal features e.g. a bell or light which indicates the completion of the toasting period. They also include a thermostatic switch, which controls the toasting period by the surface temperature of bread. These toasters do not include the pop up feature. Some-

times they are provided with a regulator with a dial to adjust the degree of brownness required.

(iii) *Automatic*

Apart from the heating element and thermostatic switch as provided in the semi-automatic toasters, there is a provision of a pop-up mechanism. In this type, after the completion of the toasting cycle, the heating elements get disconnected and the bread is also automatically expelled. Also, this type of toaster does not become "ON" unless the bread is loaded in the carriage of the toaster and the racks closed which, in turn close the mini contacts and complete the circuit for the elements.

The toasters are sometimes also provided with a selector knob indicating "Keep Warm" in one position and "Pop-up" in the other. When it is set in the "Keep Warm" position, the current will shut off at the end of the toasting cycle but the bread will not pop-up.

Another type of automatic toaster is provided with a motor operated mechanism to jog (inch) the bread between the two heating elements and shift its position. In this type, the bread does not need to be reversed and also it gets uniformly brown.

Tools and Materials

(i) Non-automatic type electric toaster complete with connecting cord.
(ii) Semi-automatic type electric toaster complete with connecting cord.
(iii) Automatic type electric toaster complete with connecting cord.
(iv) Heating elements of the required size, shape, wattage and voltage ratings.
(v) Thermostatic switches of the required size, type, shape voltage and current ratings.
(vi) Indicating lamps of the required type, size, shape, voltage and current ratings.
(vii) Workable cords, three core.
(viii) Three-pin plug top, 250 V, 5 amps.
(ix) Emery paper "00" no.
(x) Malasya cloth 1 metre.
(xi) Porcelain beads of the required size.
(xii) Porcelain cleats of the required size and shape.

Tools

(i) Hair brush 5 cms (round/flat).
(ii) Multimeter/AVO meter.
(iii) Test lamp.
(iv) Test prods.
(v) Insulated combination pliers 15 cms.
(vi) Screwdriver 15 cms.
(vii) Screwdriver 10 cms.
(viii) Screwdriver philips type 15 cms.
(ix) Screwdriver philips type 10 cms.
(x) Off-set screwdriver 15 cms.
(xi) Flat-nose pliers 15 cms.
(xii) Long-nose pliers 15 cms.
(xiii) Round-nose pliers 15 cms.
(xiv) Tweezer 15 cms.
(xv) Tweezer 10 cms.

Circuit Diagram

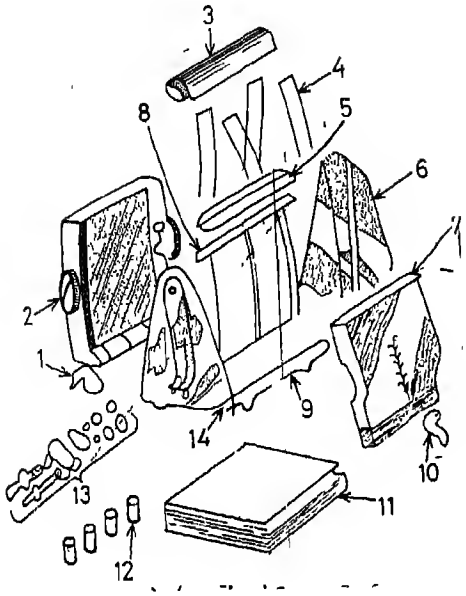

Fig. 11.1 Dismantled View of Non-automatic Toaster.

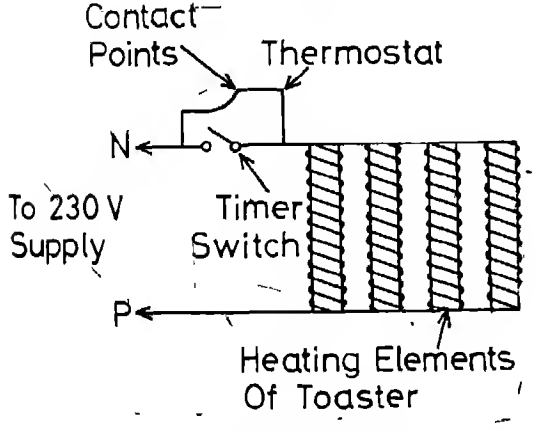

Fig. 11.2 Element Connected through Thermostat and Timer Switch.

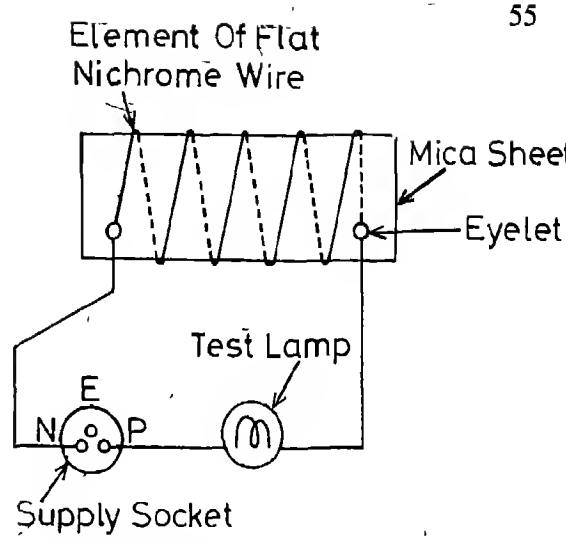

Fig. 11.3 Continuity and Short Circuit Test on Toaster Element.

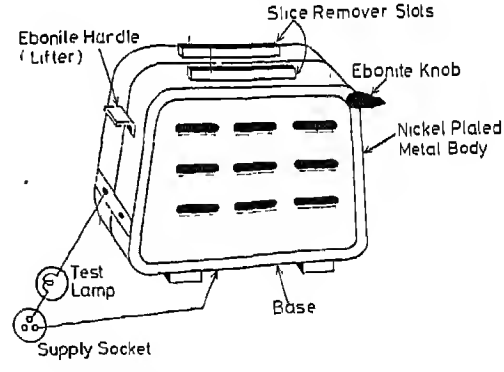

Fig. 11.4 Earth Test on Toaster.

Procedure

A. *Non-automatic Type*

(i) Check the supply in the wall socket by a test lamp.

(ii) Open the hinged racks and clean thoroughly with a hair brush/-Malasya cloth.

(iii) Check the toaster for continuity and short-circuit with the help of the test lamp/multimeter/AVO meter.

(a) While testing with the test lamp, if it glows dimly, it indicates continuity; if doesn't glow, it indicates open circuit; and if it glows bright, it indicates short-circuit.

(b) While testing with the multimeter/AVO meter, if it shows resistance, it indicates continuity; if shows infinity, it means open circuit; and if shows zero, it means short circuit.

(iv) Check the toaster for earth fault with the help of the test lamp by connecting one end of the testing lead to any one of the terminals and the other end to the metallic part of the toaster. If the lamp glows, it indicates the earth fault.

(v) In case the element is burnt or broken and needs replacement, then —

(a) disconnect the leads;

(b) remove the mounting screws, nuts, washers, bread guide wires until the damaged element is ready for removal;

(c) remove the damaged element;

(d) select the new element of the required size, shape, voltage and wattage and check it for continuity and short circuit as explained in step (iii).

(e) replace the element carefully, so that the nichrome ribbons/ elements or mica strips do not get damaged.

(vi) See that the mica washers are replaced and the connections are tight and properly insulated from the frame or body of the toaster.

(vii) In the case of earth fault, see where the conductor has come in contact with the frame of the toaster i.e. there may be a broken conductor, defective bead, touching of element with the body, touching of conductor with the earth terminal in the plug top, flat plug, etc.

(viii) Re-fix the bread guide wires, mounting screws, nuts, washers, etc. in the appropriate positions.

(ix) Connect the cord.

(x) Check again the toaster with cord or continuity/short-circuit and earth faults as explained in steps (iii) and (iv).

(xi) Load the toaster by putting bread slices in the hinged carriages and connect it with the supply mains.

B. *Semi-automatic and Automatic Types*

(i) When the toaster fails to heat up, it means there is an open circuit either in the toaster or in the cord or its attachments. Check the circuit upto the terminals of the toaster i.e. the cord, plug top, etc. If found O.K., means the fault lies inside the toaster.

Check the inside units separately e.g. connecting wire, carriage lever switch, thermostatic switch, heating elements, contacts, etc. See whether any of the contact points need

cleaning; if so, do it with emery paper or carbontetra-chloride. And if any other accessory is found defective, repair/replace it.

(ii) When the toaster does not toast the bread uniformly, it means that either the heater element does not match properly and should be replaced or the jogging (inching) mechanism has gone wrong. In this case, check motor's performance and mechanism; repair or replace as the case may be.

(iii) If the toaster does not toast the bread to the required colour, set the toasting period by adjusting the control switch.

(iv) When the toaster fails to pop-up, it means it is mainly due to a defective thermostatic switch or timing clock, contacts of thermostat, bent or defective pop-up wire, broken, carriage elevator springs or binding dash pot piston.

The contact switch assembly and contact points must be cleaned with emery paper or carbontetra-chloride. Check the thermostat for opening/closing of contacts by the test lamp/multimeter/AVO meter and if found defective, replace it. Also check the carriage elevator springs and see that they do not rest against the beam.

Tabular Record of Observations

Continuity/short-circuit test on heating elements.

	Lamp	*Multimeter*
Open circuit	No light	Infinity
Short circuit	Full light	Zero
Perfect	Dim	Reading

Precautions

(i) Before dismantling the toaster, first explore the possibility of making adjustments and learning the cause of failure from outside.

(ii) When a particular model of toaster is taken up for the first time, spend some time to study its method of operation and exact function of every part.

(iii) Pad the work bench with several layers of soft cloth in order to prevent scratching and keep away all the tools from the padded area.

(iv) While removing or placing back the bread guidewires, see that they do not get entangled with the heating elements.

(v) Never patch any portion of the resistance of the element, when found burnt/open. Replace the element with a new one.

(vi) Erratic operation of the timer while testing should be avoided since it causes damage to its components.

(vii) If the timer unit/thermostatic switch is a sealed unit, never dismantle/-repair it, rather, replace it. And if it is of the adjustable type, set it only when it is at room temperature.

(viii) For measured clearances and critical adjustments, consult the manufacturer's manual.

(ix) Ensure that the mechanical movements are precisely aligned, accurately adjusted and lubricated at all points, as recommended by the manufacturers.

(x) Under no circumstances should the bimetal be bent or tampered with, otherwise it will get damaged.

(xi) Clean the toaster inside and outside before carrying out any repairs.

(xii) Ensure that all the contacts e.g. 3-pin socket, terminals flat plug, etc. are properly cleaned and made proper contacts.

Questions for Evaluation

(i) How do we check the heating element for continuity and short circuit?

(ii) Why it is not desired to patch the heating element?

(iii) What is the function of "Keep Warm" control?

(iv) Why it is necessary to have proper earth connections with the toaster?

(v) How do we clean the contacts?

(vi) What is to be done when the toaster does not toast the bread to the desired colour?

(vii) What could be the possible defects when the toaster fails to pop up?

References

(i) *How to Repair Small Appliances* by Jack Darr.

(ii) *Audles Home Appliances Service Guide* by Edwin P. Anderson.

(iii) *Small Appliances Servicing* by P.T. Brock Well, Jr.

(iv) *Electric Gadgets and Their Repairs* by Rao S.L. and Sadana O.P.

(v) *Elements of Electrical Gadgets* by Bhatia.

Experiment No. 12

Title of Experiment

To study, test, dismantle and reassemble an electric oven/cooking range.

Specific Objectives

(i) To study the cooking range.
(ii) To dismantle the cooking range.
(iii) To reassemble the cooking range.
(iv) To test the cooking range.

Introductory Information and Related Theory

An electric range works on the same principle as a stove, i.e. when current flows through resistance, heat is produced. An electric range is generally used in restaurants, hotels, canteens and modern kitchens. It is bigger in size than hot plates, therefore, it is placed on a particular specified place, whereas hot plates are portable. A modern electric range is shown in the Fig. 12.1. It is available in the shape of an almirah also.

An electric range is used for cooking, baking cakes and to keep the food hot. We can also use it to boil curries and fry food.

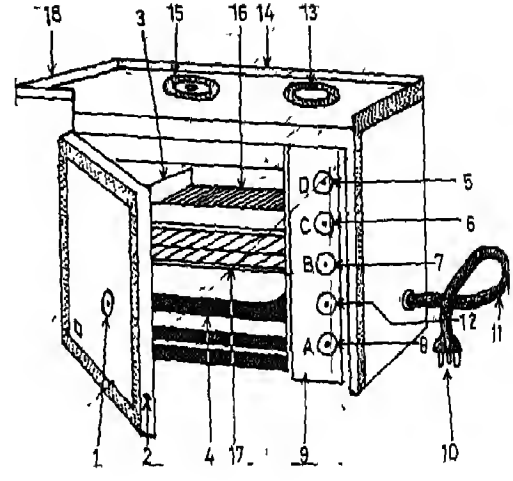

Fig. 12.1 Electric Oven and Cooking Range.

The following are the parts of an electric range:

Surface Heating Unit

It is provided in the topmost position of the electric range. In this position, simple hot plates are provided to boil milk or to cook food. Heating units used for the hot plates in the surface heating unit are of three types: (i) open coil; (ii) solid plate type; (iii) tube type.

Open Coil Type: In this type, ordinary table heaters are used in which low range coiled coil nichrome elements are used.

Solid Plate Type: A hot plate may also be provided in the surface heating unit. In this type, the heater element is not visible. This type of plates take much more time to become hot and to cool down, so the solid plate type heaters are generally used in the hotel type of electric cooking ranges.

Tube Type: In a modern electric range, the tube type heating unit is provided. In this type of unit, the tubes are generally of triangular shape, because greater heat radiating surface comes in contact with the plate. An element of nichrome wire is fitted in this tube. To insulate the tube from the coil, magnesium oxide powder is poured in it as an insulator. The tube is provided with a sheathing of nickel or chromium. At the ends, the tube is sealed with glass seal and lava bushing with welded lead terminals at both ends of the tube.

Oven: Electric oven is also provided in the electric range. In the oven, food is cooked by the radiation of heat. The heating units, one at the top and the other at the bottom, are provided to heat the oven. A tray if also provided to keep the food to be cooked by radiation of heat from all sides.

Type of Oven Heating Units: In every type of heating unit, two tube type heating elements are provided. The elements are covered with a shield of heavy gauge sheet. If one of the elements is fused, then both the elements must be replaced. Both surface heating units and the oven heating units are controlled for three types of heats: (i) low heat; (ii) medium heat; (iii) High heat. The control switches for a particular type of cooking, shown in Fig. 12.1, are used for the following purposes.

Switch D — For controlling the right side hot plate.

Switch C — For controlling the left side hot plate.

The respective positions for switches C and D mean:

When on 0 — Off

When on 1 — Low heat (300 watts)

When on 2 — Medium heat (only one coil working, 600 watts)

When on 3 — High heat (1250 watts)

Switch B — This is a thermostat switch which regulates automatically the temperature of the oven chamber as required, in the range of 50°C to 300°C.

Pilot Lamp: The pilot lamp is for the oven only; the oven switches on and off according to the inside temperature reached and the pilot lamps late know by its on/off position.

Switch A — For controlling the heating elements in the oven, the various position of this switch denotes the following:

When on 0 — Off

When on 1 — Both top and bottom elements working, low heat (300 watts).

When on 2 — Only top element working, medium heat, grill (600 watts).

When on 3 — Both top and bottom elements working, high heat (1200 watts).

Thermostat: It is an automatic device

to control the heat. Almost all electric ranges have a thermostat. There are two types of thermostats: (i) bimetallic type; (ii) hydraulic type.

Bimetallic type: There are two types of bimetallic thermostat (i) helical coil type; (ii) flat blade type.

Helical Coil Type: There are two strip coils of different metals having different temperature co-efficient of expansion. As these metallic springs expand, they break contact with the switch. They contact when they cool and the contact is made. Hence, the electric oven works automatically. The temperature of the oven is preset by adjusting the screw.

Flat Blade type: This type of thermostat is usually used in electric irons, electric toasters, etc.,

Hydraulic thermostat: In this type of thermostat, one capillary tube alongwith a bulb is provided; this tube is filled with a liquid. This bulb is kept in the oven as shown in Fig. 12.3. When it gets heated, its liquid also gets heated and the liquid filled in the tube expands and rushes towards the flexible bellows. This liquid disturbs the position of the bellows and the contact of the thermostat opens and the oven stops working. When the temperature reduces again, the contacts are connected and the oven starts working again. For adjusting the heat, an adjusting dial is also provided. By adjusting the knob, we can adjust the heat and temperature of the oven. A timer is also provided in it; the connections of the timer are shown in Fig. 12.3. It is also provided with an ordinary watch which works with electricity or with a key. By adjusting the timer, the oven stops working after the prefixed time. The time is set in accordance with the food to be cooked and in how much time it will be cooked.

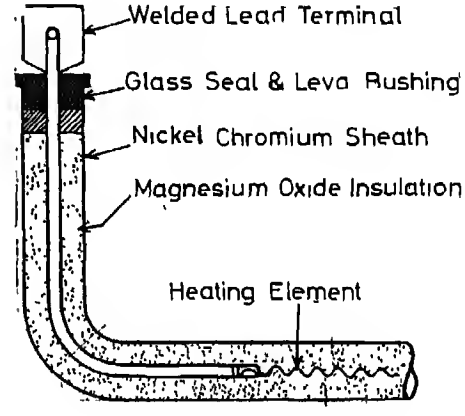

Fig. 12.2 Tube Type Heating Element.

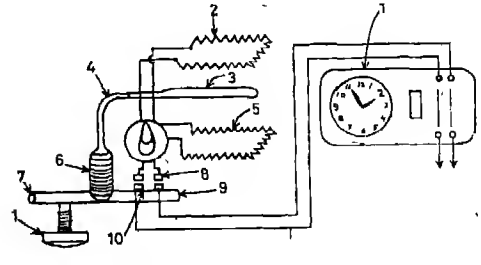

Fig. 12.3 Schematic Diagram of Typical Oven Control Arrangement.

Equipment and Materials

(i) Cooking oven with electric range.
(ii) Insulated cutting pliers.
(iii) Screwdrivers.
(iv) Series parallel testing boards, etc.

Procedure of Dismantling and Reassembling

Disconnect the range from the source of electric supply. Lift the heating unit assembly out of the range, detach the three leads and the ground connection from the unit terminals. The dismantling of the surface unit control switches may vary from model to model. Some ranges have their surface unit control switches located on the front panel above the utility drawer, whereas other ranges have their switches mounted on the rear panel, adjacent to the wall. In each instance, the procedure will be identical. Each one of the surface unit control switches can be removed independently of one another. With the switches located on the front part of the range, it is only necessary to lift the range top to gain access to the switch panel and disassemble the lower and upper oven units by disconnecting the element wire from the terminal blades. Since there is no standard mounting of range thermostats, each range model requires its own method of dismantling. After removing the oven control knob, the timer set knob and the wiring can be dismantled. The timer can then be removed.

Reassembling

The reverse procedure of disassembling achieves assembling.

Precautions

(i) Before dismantling, the supply and cord should be taken out of its connection.
(ii) Use always a 3-core cable for the supply cord and a 3-pin plug should be used.

Testing

After reassembling, the cooking range is to be tested for (i) open circuit test; (ii) short circuit test; (iii) leakage test; (iv) earth fault test.

Troubleshooting Guide

Sl.No.	*Trouble*	*Cause*	*Remedy*
1	2	3	4
1	Oven does not work	1. Fuse might have blown off	Check the supply fuse and if it is blown off, replace it according to the capacity of the range. Check the fuse of the oven which is provided at its back; if it is fused, replace it.

1	2	3	4
		2. Connections in wall socket or 3-pin plug top may be disconnected or loose.	Check the connections, if broken, make connections again, if loose, tighten the connections
		3. Short circuit in the oven circuit (Short circuit may occur in the hot plate or the terminals of the indicating lamp.)	Check with the series lamp, remove the short circuit.
2.	Interference in radio	It is due to the quick make and break of circuit in the oven or electric range because of a damaged thermostat.	Set the thermostat properly. If it gives interference even then, change the thermostat.
3.	One gets a shock while working	Due to the improper earthing provided to the electric range.	Earth the range properly. Then if there is any leakage current, the fuse will be blown off and the person will not get a shock.
4.	Gives a humming noise	Due to loose fitting of heating unit. When A.C. supply is given to it, the magnetic field of greater strength is produced and it gives a humming noise.	Tighten the heating unit. Humming noise due to the electric watch cannot be removed.
5.	When the electric range works, other electrical lamps give dim light.	1. Electric range and lamps are connected to the same circuit	There should be separate circuits for the range and the lamps.
		2. Due to less supply voltage	Three-phase 4-wire supply system should be provided in houses where the ranges are to be used.

1	2	3	4
6.	One surface heating unit does not work	1. Fault is in the circuit of the particular heating unit.	Check with the series lamp for the continuity of the circuit; rejoin the break, the heating unit will start working.
		2. Rotary switch might not be working	Check for loose connections of the switch. If the contact is properly made, and even then, there is trouble, replace the switch.
		3. Short circuit in heating unit	Test with the series lamp; if short circuit is observed remove the short circuit.
		4. Heater element might have been fused.	Check the heater element with the series lamp; if it does not glow, there is a break in the element, change the heater element.
7.	Surface heater gives excessive heat.	It is due to excessive voltage supplied to the heater.	Check the voltage with the voltmeter; if voltage is more, supply rated voltage only.
8.	Surface heater burns intermittently	Due to loose connection	Check and tighten the connections.

Questions for Evaluation

Fill in the blanks with appropriate words.

(i) The heating units used for the hot plates in the surface heating unit are of three types 1)..... 2)..... 3).....

(ii) ..... insulting material is used for the insulation of the heating element from the tube in the tube type heating unit.

(iii) ..... type surface heating unit

is usually used in the hotel type electric cooking range.

(iv) (1)..... and (2)..... type thermostats are used for controlling the heat in a cooking range.

(v) The humming noise is due to the ..... of the electric cooking oven and range.

(vi) The pilot lamp is provided in the electric oven/range for the purpose of .....

References

(i) *Home Appliance Servicing* by Edwin P. Anderson (Audel series).

(ii) *Electrical Appliances (Theory and Repair)* by Anwani.

(iii) *Electrical Appliances (Repair and Maintenance)* by K. Nath.

Experiment No. 13

Title of Experiment

To study, test and repair an immersion heater.

Specific Objectives

To acquire skill in the testing, maintenance and repair of an immersion heater.

Introductory Information and Related Theory

Immersion heaters are being increasingly used in homes to heat water in buckets, drums, etc. They work on the heating effect of electric current, normally available in wattage ranges from 250 watts to 2 Kw. A heating element in a coil of nichrome wire is stretched concentrically inside a seamless copper tube and filled with magnesium oxide under vibrations. The tube is built in various shapes, the end connections are sealed and the entire tube is chrome plated. The leads are connected through an iron

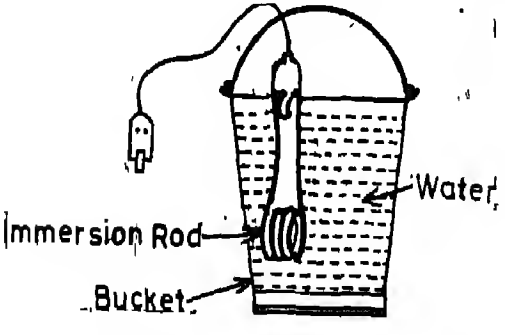

Fig. 13.1 (a) Immersion Heater Dipped in Water.

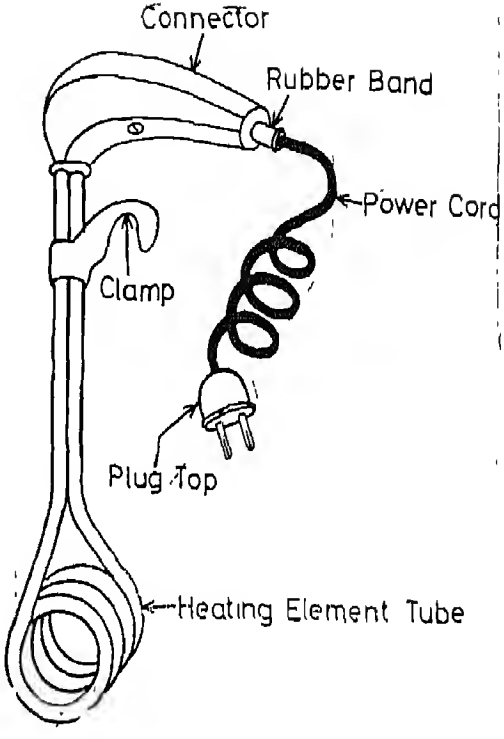

Fig. 13.1 (b) Parts of Immersion Heater.

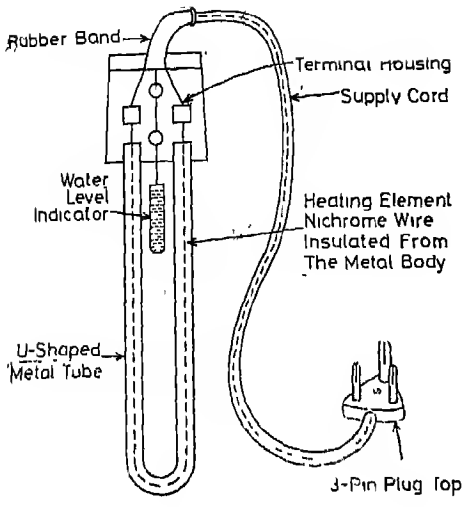

Fig. 13.1 (c) Parts of Immersion Heater U-shaped.

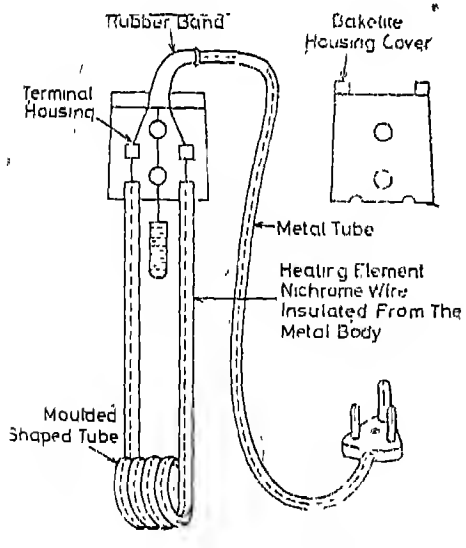

Fig. 13.1 (d) Parts of Immersion Heater Moulded Make.

connector. The earth point with the connector is so provided that it works as a hanger to the rod to be dipped in water. It also provides good earthing to the bucket as shown in Figs. 13.1 (a), (b), (c), (d) (e) and (f).

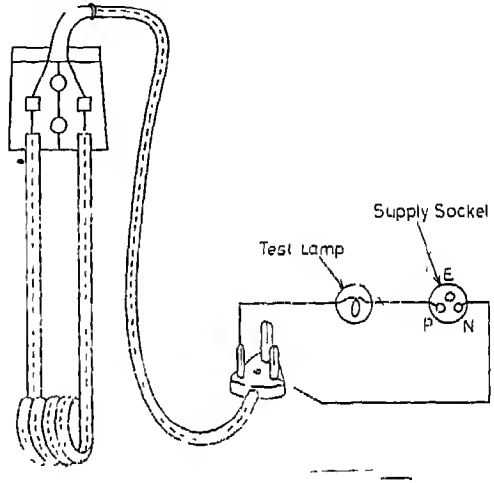

Fig. 13.1 (e) Testing of Immersion Heater, Open Circuit, Short Circuit and Continuity.

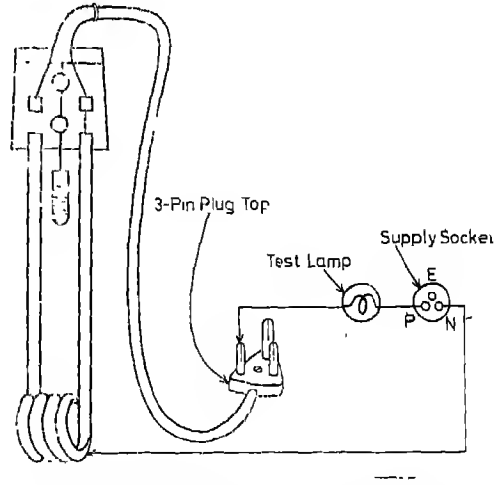

Fig. 13.1 (f) Leakage Test on Immersion Heater.

Materials and Tools Required

Insulated combination pliers, common screwdriver, test lamp 40 W with testing leads, line tester, etc.

Main components of an immersion heater: metal body of water heater —moulded shape or U-shaped. Terminal housing made of ebonite or bakelite to hold terminals. Rubber band for the flexible cord to protect the cord from being damaged. Three-core cord for supply. Three-pin plug to give supply. Terminals with screws and housing screws to tighten the wire

Procedure

(i) *Testing Procedure*

Prepare the series test leads to test the water heater for open, closed, short circuits and earth or leakage tests, by connecting the two ends of the testing leads to the terminals of the plug top of the water heater. If the lamp does not give light, it means there is open circuit i.e. breakage of element wire inside the body of the water-heater, disconnection of wire ends from the terminals of the water heater or from the terminals of the plug top, there may be breakage in the flexible cord of water heater. If the lamp gives bright light, it means, there is a short circuit i.e. the wire ends at the connector terminals or at the plug top are touching or the insulation of both wires in the cord is leaking.

If the lamp glows dimly, it means the element of the water heater is in working order and it is known as a closed circuit. Now to perform the test for earth fault, connect one end of the testing lead to one terminal of the plug top and another to the metal part or body of the water heater. If the lamp glows, it means there is an earth fault i.e. some part of the element is touching the metal body of the water heater. If any spark occurs on the metal body, it means the insulation inside the body is leaking from somewhere, which is known as a leakage fault.

(ii) *Repairing Procedure*

In the case of open or short circuit defects, check the flexible cord and plug top and the wire ends at the terminals in the connector of the water heater for their discontinuity and touching ends, and correct them. If the cord is too old, replace it. If the terminal housing is broken, replace it. If any screw is missing, get another one and tighten it.

In the case of earth fault, check that the coming ends of the element from inside the body of the water heater are not touching the corners of the metal part of the water heater. If the earth fault is from inside the metal body of the water heater, it cannot be repaired and the complete element need replacement.

Observations

Some Common Results in Tabular Form

S.No.	*Fault*	*Possible causes*	*Testing*	*Rectification*
1	2	3	4	5
1.	Immersion rod not warming	1. Open of heating element in the rod	1. Open circuit test	1. Check and replace the complete immersion heater.
		2. Blown out fuse	2. Short circuit/-earth fault	2. Check the fuse and remove the short circuiting point in the connector or in the plug top or if the immersion rod is earthed, replace the element.
		3. Defective switch/loose connection	3. Open circuit test or physical observation	3. Check and replace or tighten connections.
		4. Fractured connecting wire at the connection points in the connector or in the plug top.	4. -do-	4. Renew connection, if fractured.
		5. Loose plug top or flat press connector	5. -do-	5. Replace or arrange screw, if missing, with a suitable plug top or connector.
		6. No power	6. Supply test by line tester or series testing lamp.	6. Check for power failure or mains fuse. If blown out, replace.
2.	Fuse blows out after replacement	1. Low capacity fuse or excessive load than planned	1. Test fuse capacity and load on that circuit	1. Put proper fuse

1	2	3	4	5
		2. Short circuit in the immersion rod or earthing of heating element in the immersion rod.	2. Short circuit/-earth fault test.	Replace immersion heater.
		3. Short exists even after disconnection of the equipment	3. -do-	3. Locate the fault point and do whatever is required.
		4. Short circuit is due to phase wire short to neutral inside the plug top/ connector/flexible cord, etc.	4. -do-	4. Replace flexible cord, if required.
3.	Bucket in which the immersion rod is dipped gives shock	1. Leakage in immersion heater rod	1. Earth fault	1. No repair possible, replace immersion heater.
		2. Puncture of heater rod and water is entering into it	2. -do-	2. -do-
		3. Open neutral	3. Check continuity of neutral wire.	3. Connect neutral wire properly.

Precautions

(i) The immersion heater should be dipped up to the indicated level. In no case should water enter the terminal housing.

(ii) Supply should be switched "on" only after the immersion heater has been dipped into the water.

(iii) Supply should be switched "off" first before taking it out.

(iv) Before testing the water heater, insulate yourself on dry wood or on a rubber mat.

(v) Test the heater in series of the electric supply to avoid the risk of failure of supply.

(vi) Never give direct supply unless you are sure that there is no fault in the water heater to avoid the risk of failure of supply.

(vii) Use a three-core flexible cord for giving supply to the heater and earth it properly.

(viii) Don't use the immersion heater in other liquids because it is meant for water only, and other liquids will have a corroding effect on its surface.

(ix) Do not attempt any repair on the immersion rod with supply connected.

Questions for Evaluation

(i) What faults may be possible in the immersion rod and how will you remove them?

(ii) Write the method of testing and show the testing diagram.

(iii) What precautions will you take at the time of using an immersion heater?

(iv) How will you ascertain that an immersion rod is safe for use?

(v) Why does the heating metal tube of an immersion heater get burnt?

(vi) Why does the heating element of an immersion heater get burnt?

(vii) Why is the water level indicated in an immersion heater?

References

(i) *Electrical Appliances Repair and Maintenance* by K. Nath.

(ii) *A Text Book on Electrical Gadgets and Appliances Volume II* by P. Venkateswar Rao and R. Santhanakrishan.

(iii) *Audel: Home Appliance Service Guide* by Edwin P. Anderson.

(iv) *Study of Electrical Appliances and Devices* by K.B. Bhatia.

Experiment No. 14

Title of Experiment

To study, test, dismantle and reassemble water boilers, e.g. electric kettle and geyser.

Specific Objectives

To acquire skill in the testing, dismantling reassembling, maintenance and repair of electric geysers.

Introductory Information and Related Theory

Geysers are being increasingly used in modern houses to heat water either continuously or intermittently. A geyser can be easily installed anywhere with electric power. Its water temperature can easily be regulated automatically by a thermostat. It works on the principle of thermal storage i.e. the water is preheated by a immersion heater in a storage vessel and is kept for future use. To keep the water hot, the storing vessel is provided with thick insulation of glass wool between the inner container and the outer casing. To minimize heat loss, the outer casing is made of mild steel sheet. The inner tank is made of heavy gauge copper, adequately tinned to resist corrosion.

The thermostat is of the micro-gap type which is adjustable from 32°C to 88°C (90°F to 190°F) by turning the screw provided on the thermostat. The screw is accessible on opening the bottom cover plates. The pilot lamp is of the neon indicator type fitted on the outer casing of the unit indicating automatic working of the unit.

Geysers are available in different capacities, ranging from 5 litres to 50 litres, with wattage ranging from 0.75 Kw to 2 Kw, etc.

Materials and Tools Required

(i) Insulated combination pliers
(ii) Common screwdriver
(iii) Insulated long nose pliers
(iv) Line tester
(v) Test lamp (40 W)
(vi) Testing leads 3/32 SWG copper wire
(vii) Insulating material — mica pieces, porcelain beads
(viii) Geyser spare parts for assembling, dismantling and reassembling.

Geyser Diagram

(i) *Circuit Diagram*

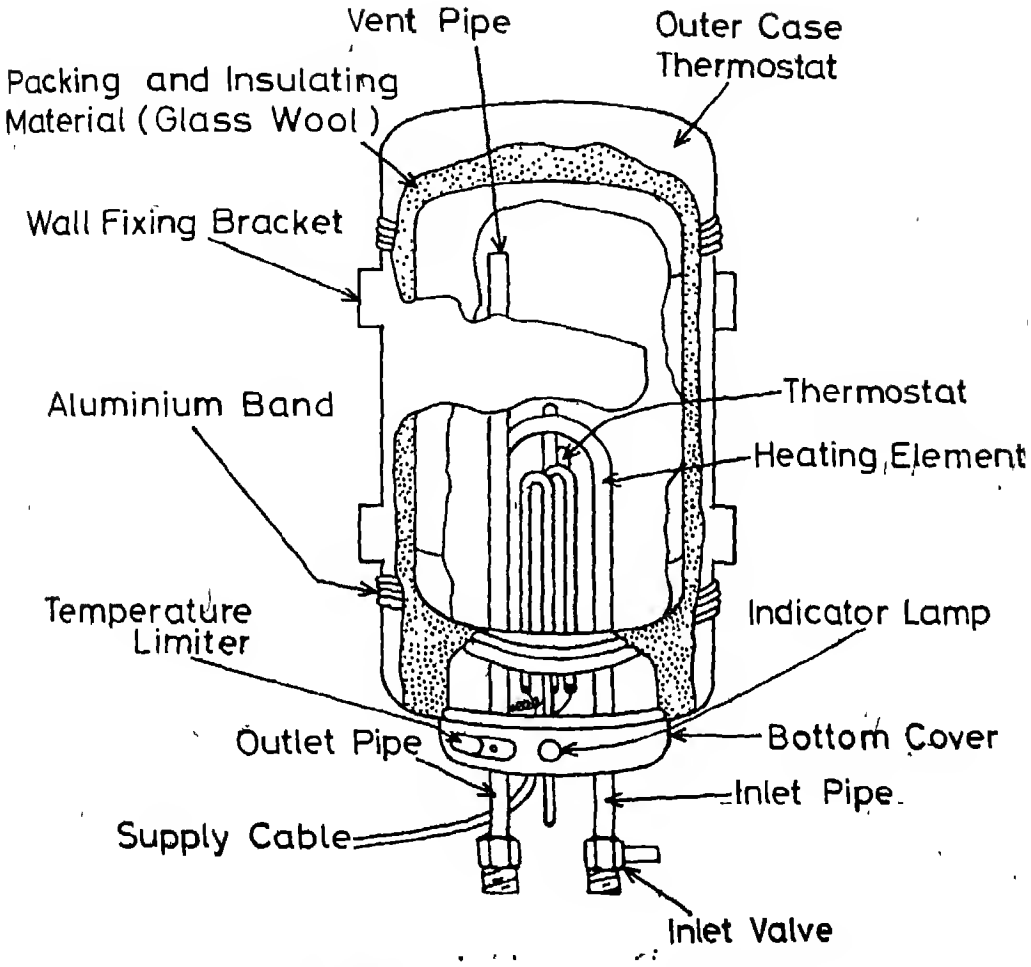

Fig. 14.1(a) Parts of an Electric Geyser.

(ii) *Electrical Connection*

The geysers are not portable appliances and so the plug and socket connections are not used. The geyser must be given supply from a separate circuit in the house. The circuit is connected to an iron clad switch and the wires from the geyser are connected to the iron clad switch. It is necessary to earth the body of the geyser to avoid electrical shocks.

Procedure

(i) *Testing and Repairing Procedure*

Supply can be checked by a simple test lamp, by connecting it with the main terminals in the main switch.

Open and short circuit in the wiring circuit may be due to breakage of wire ends from the terminals or breakage inside the wires and touching of wire ends together, or bare wires touching somewhere. The breakage inside the wires or touching of bare wires and can be checked with the help of a series test lamp, by disconnecting the connections from the geyser and the main switch and connecting one end of the test lamp at one end of the wire and the other end of the test lamp with the other end of the same wire. If the lamp does not glow, there is breakage in the wire. If it gives continuity with another wire, then there is a short circuit and the fuses will be blown off. Replace the wire or insulate it.

The heating element may be defective or burnt. It can be checked with the series test lamp by disconnecting the main connections. If the element is burnt, the lamp will not give any continuity.

It can also be tested for earth or leakage fault by touching one end of the test-lamp to any one terminal of the element and the other end of test lamp to the metal part of the element. If there is an earth fault, the lamp will give light. If there is sparking, there will be leakage fault. The element will have to be replaced in the case of earth fault. To replace it, one need not to open whole geyser — only opening of the nut at the bottom is sufficient and the element will come out.

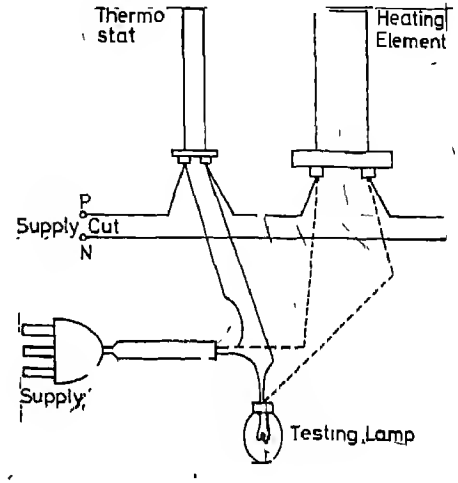

Fig. 14.1(b) Testing of an Electric Geyser.

The thermostat device may be defective, or the setting may not be proper or there may be leakage.

This can also be tested by the series test lamp and replaced, if necessary.

(ii) *Maintenance and Care Procedure*

A geyser requires no maintenance. However, the life of many units can be increased by periodic draining. This removes mineral deposits which may attack the inside surface. How often you need to do this depends on the amount and kind of minerals in the water, but draining cannot do any harm, even if you do it more than necessary.

Observations

Some Common Faults in Tabular Form

S.No.	*Faults*	*Possible Causes*	*Testing*	*Rectification*
1	2	3	4	5
1.	No hot water	1. No power	1. Test supply by the line tester or series testing lamp	1. Check for power failure or if the main fuse is blown out, replace
		2. Blown out fuse	2. Short circuit/earth fault	2. Check the fuse and remove the short circuiting point. Heating element or geyser point may be earthed, replace or repair accordingly.
		3. Calcium build up on heating element	3. Physical observation	3. Remove element and clean.
		4. Heating element burnt out	4. Continuity/open circuit test	4. Replace faulty element if it has fused.
		5. Defective switch or loose connection	5. Open circuit test and physical observation	5. Check and replace or tighten connections.
		6. Fractured connecting wire at the connection points or in the cable	6. -do-	6. Renew connection or cable, if fractured.
		7. Earth fault in heating element/leakage in element	7. Continuity test/-open circuit in thermostat	7. Adjust the thermostat setting.
2.	Water not sufficiently hot	1. Thermostat setting too low	1. Physical observation	1. Adjust the thermostat setting by turning the screw provided on the thermostat.

1	2	3	4	5
3.	Steaming hot water	1. Thermostat contacts burnt	1. Examine by opening the bottom cover plate of thermostat	1. If thermostat terminals are burnt, replace, if necessary.
4.	Fuse blows out after replacement	1. Low capacity fuse or excessive load than planned	1. Test fuse capacity and load on the circuit	1. Put proper fuse.
		2. Short circuit or earth fault in the geyser heating element	2. Short circuit/earth fault test	2. Replace heating element
		3. Short exists even after disconnection of the equipment	3. -do-	3. Locate the fault point and do whatever is required
		4. Short circuit is due to phase wire short to central at the terminals of the geyser or at the point from where supply is taken or in between these points	4. -do-	4. Remove short circuit, put insulated tapes, if required. Replace cable, if fault is in the cable.
5.	Geyser giving shock	1. Leakage in heating element	1. Earth fault	1. No repair possible, replace heating element
		2. Puncher of heating element and water is entering into it	2. -do-	2. -do-
		3. Open neutral	3. Check continuity of neutral wire	3. Connect neutral wire properly
6.	Water leaks	1. Rusting of joints in the pipe line adjacent to hot and cold water lines	1. Physical observation	1. Replace pipe if necessary
		2. Leaky container because of decay in container it due	-do- It can also be tested by putting air pressure inside the containers and dipping it into water	2. Replace entire container

Precautions

(i) Open cold water control valve, wait till the cold water flows from the outlet and switch 'on' the supply.

(ii) Adjust the flow of water for your requirement of hot water i.e. more flow, lower temperature, less flow, higher temperature.

(iii) Switch off the unit before closing the control valve, though the thermostat will cut off automatically when the temperature inside the tank reaches the thermostatic setting.

(iv) Before testing the geyser, insulate yourself on dry wood or a rubber mat.

(v) Test the heater in series of the electric supply to avoid the risk of failure of supply.

(vi) Never give direct supply unless you are sure that there is no fault in the geyser to avoid the risk of failure of supply.

(vii) Don't attempt any repair on the geyser with the supply connected.

Questions for Evaluation

(i) How will you ascertain that a geyser is safe for use?

(ii) Why is glass wool packing provided in a geyser?

(iii) State the probable faults in a geyser.

(iv) What is the purpose of the thermostat in a geyser?

(v) What possible faults may be in the geyser and how will you remove them?

(vi) Why does the heating element of a geyser get burnt?

(vii) What precautions will you take at the time of heating a geyser?

References

(i) *Electrical Appliances (Theory and Repair)* by Anwani.

Experiment No. 15

Title of Experiment

To study, test, dismantle and reassemble a table fan.

Specific Objectives

(i) To study a table fan
(ii) To dismantle a table fan
(iii) To reassemble a table fan
(iv) To test a table fan

Introductory Information and Related Theory

An electric fan is one of the most common household appliances. It is designed to circulate the air within a room particularly during the hot season of the year. In its simplest form, an electric fan consists essentially of a small electric motor having usually four propeller-like blades mounted on its shaft. When the motor is actuated, the rotary motion of the shaft forces the blades to circulate the surrounding air. Modern electricity operated fans may be divided into several classes, depending on their operation and method of mounting. These classes are:

(i) Table fans (oscillating or non-oscillating)
(ii) Floor fans
(iii) Window fans

Let us study the table fan only in this experiment. The familiar oscillating and non-oscillating fans are commonly mounted on a heavy base or pedestal and or furnished with a set of blades. The blades are protected by a suitable wire guard. The type of motor used depends on the size of the fan and may, in the case of smaller fans, be of the shading pole or universal type; the larger fans are usually furnished with a capacitor or split phase type motor. The only fans that may be operated on either alternating current or direct current are those that are driven by the universal type motor.

Oscillating fans are so termed because they oscillate in a back and forth motion as the motor and fan rotate. In this manner, they can move a large volume of air in the room or area in which the fan is placed. The oscillating mechanism consists of a worm gear on the

motor shaft that engages a gear on a short jack shaft. This shaft has a worm gear on the other end and is meshed with a gear on a vertical shaft. A disc attached to the lower end of the vertical shaft rotates at very slow speed, and by means of a short lever attached to the disc at one end and the motor at the other end, the fan is caused to rotate back and forth. This principle is employed in most oscillating fans, although some models employ a vertical shaft with a knob that is built into the gear mechanism with a clutch device. This design permits the fan to be used either as a stationary or oscillating model.

Main Components of a Table Fan

(i) Metal body made of cast iron.
(ii) Stator made of lamination of iron cores.
(iii) Stator winding (running and starting winding of enamelled or aluminium wires).
(iv) Rotor (assembled with copper bars and pressed under hydraulic pressure with iron cores and short circuited on both sides).
(v) Front and back side covers made of cast iron, fitted with bushes or ball bearings.
(vi) Back canopy.
(vii) Oscillating gear box.
(viii) Front canopy.
(ix) Stand and base.
(x) Base cover or end plates.
(xi) Oscillating rod and knob.
(xii) Regulator and knob.

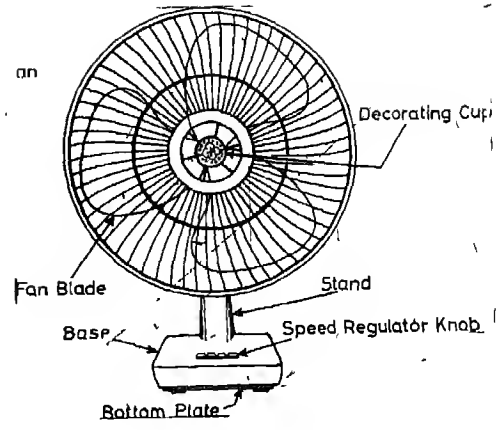

Fig. 15.1(a) Parts of a Table Fan.

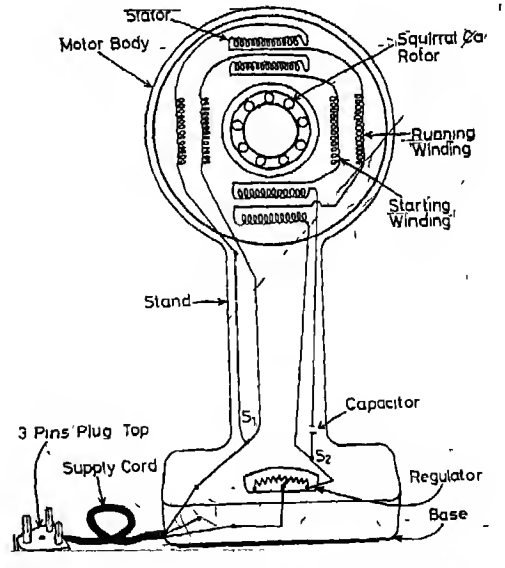

Fig. 15.1(b) Internal Winding Diagram of a Table Fan.

(xiii) Condensor.
(xiv) Blades.
(xv) Front and back wire guards for

safety.

(xvi) Nuts, bolts, washers, handle and other insulating materials according to requirement.

Equipment and Materials

Table fan, small screwdriver, insulated cutting pliers series parallel testing board, etc.

Circuit Diagram

The running and starting windings with regulator capacitor connections are shown below:

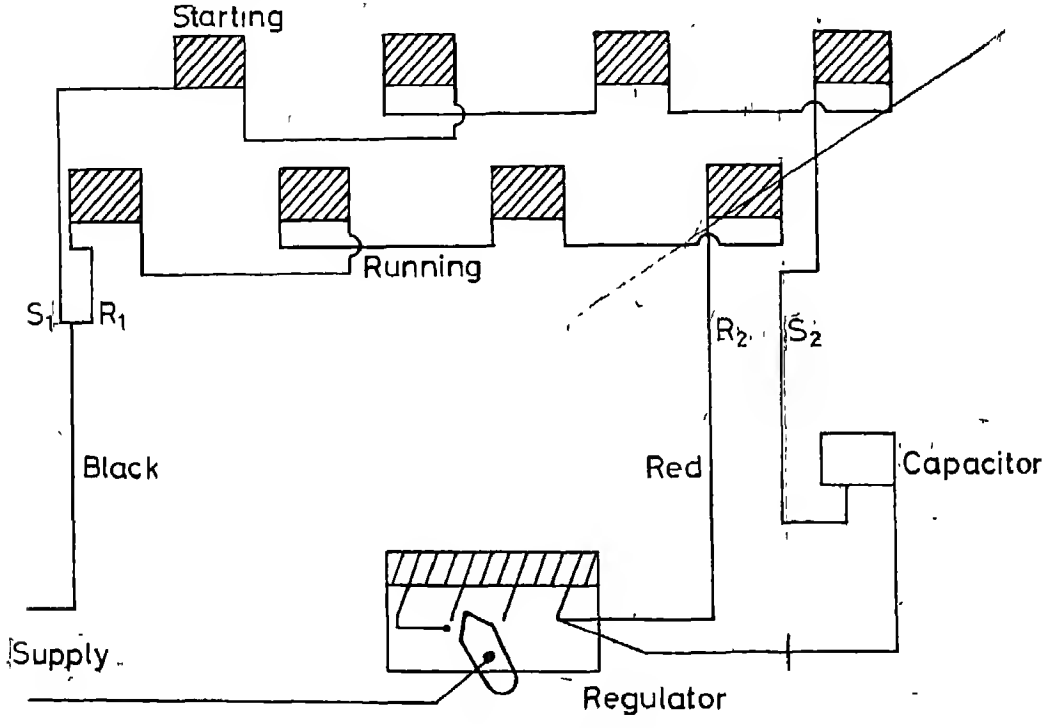

Fig. 15.1(c) Winding Connections of a Fan.

Procedure

Method of Dismantling

Remove the hooks from the sides of the guards and remove the front guard. Loosen the screw of the blades and separate the blades. Loosen the screws of the back guard, remove them and separate the back guard. Remove the oscillating knob. Mark the points on the side covers with canopies on the body of the table fan. Loosen the screws of the back and front canopies and separate them. Loosen the screws of the oscillating assembly, remove them and separate the gears. Loosen the nuts and bolts of the side covers, remove them and separate. Disconnect all the connections of windings, capacitor and regulator. Clean all

the parts.

Testing and Reassembling

Test the windings and capacitor for open, short, earth and leakage faults by the series test lamp. Check also the regulator for open, short and earth faults. If there is any defect, remove it and reassemble all the components properly. Trace the connections of the main winding, starting winding, capacitors and regulator. Do the connections and check the fan finally with series testing leads and give the direct supply if there is no fault in it.

Precautions

(i) Do the testing in series of the supply.

(ii) Do not oil excessively or when the fan is in motion.

(iii) Fan body should be earthed properly.

(iv) At the time of overhauling and repairing, care should be taken to prevent all the parts from being damaged.

(v) Avoid scratches while laying the fan on the floor or a table by using a pad of clothes.

(vi) Use of a table fan should be avoided if there are children in the house. If used, it must be earthed and have a good grill.

Troubleshooting Guide

S.No.	*Trouble*	*Cause*	*Remedy*
1	2	3	4
1.	Fan is not working	1. Dry bearing or bush	Pour oil and put grease
		2. No supply in wall socket, leads broken, regulator open	Rectify the fault
		3. One blade is in bent position or it is out of the proper angle	Cut off the supply by taking out the plug from the wall socket. Rotate the blades by hand and check that the blades do not touch the grill. If they do, open the grill and set the blades right by bending the blades gently.

1	2	3	4
2.	Fan is rotating at low speed and becomes hot	1. Capacitor is burnt out	Charge the capacitor for a minute. Short circuit the terminals with a screw-driver; if no spark occurs, it indicates that the capacitor is not good. Replace.
		2. Worn bearings	Bearings are to be replaced.
		3. Blades bent	Blades are to be corrected.
		4. Winding earthed	Test with the test lamp and rectify the fault.
3.	Fan shivers while working	Blades are bent	To set the blades in the correct position, take them out by opening the grill, place these blades on the flat and clean floor in such a position that all the blades touch the floor, If any one blade is not touching, push it downwards so that all the blades touch the floor. Use a mallet for beating the blades.
4.	Fan gives shock	1. Winding may be earthed	Find out the earthing point and rectify the trouble
		2. Capacitor or regulator may be earthed	Find out where the earthing point is and rectify the trouble.

Questions for Evaluation

Fill in the blanks with the appropriate words.

(i) Table fans are of two types:
(a) _____
(b) _____

(ii) The oscillating mechanism consists, essentially of a _____

(iii) Usually there are two types of regulators used in table fans:
(a) _____
(b) _____

(iv) The types of motors used in table fans are:
(a) _____
(b) _____

(v) In the case of capacitor motors, there will be two windings to facilitate_____

(vi) A fan becomes hot due to
(a) _____
(b) _____
(c) _____

(vii) If the capacitor is out of order, the fan does not _____ but _____

References

(i) *Study of Electrical Appliances and Devices* by K.B. Bhatia.
(ii) *Electrical Appliances Repair and Maintenance* by K. Nath.
(iii) *Electrical Appliances (Theory and Repair)* by Anwani.
(iv) *Home Appliance Servicing Guide* by Edwin P. Anderson.

Experiment No. 16

Title of Experiment

To study, test and dismantle a ceiling fan.

Specific Objectives

(i) To understand the constructional details of a ceiling fan.

(ii) To practice dismantling and assembling of a ceiling fan.

(iii) To test and troubleshoot in a ceiling fan.

Introductory Information and Related Theory

The electric fan is a common household appliance these days. It is designed to circulate air within a room, particularly during the hot season. The ceiling fan in its simplest form consists of an A.C. split phase capacitor type induction motor or shaded pole motor. Nowadays, shaded pole type ceiling fan motors are becoming absolete and the more commonly used ones are of the split phase type. the constructional details are shown in Fig. 16.1 (a) and (b). The main parts of a ceiling fan are the stator, rotor, body and fan blades. The motor is a rotating part of the fan (outer part) and the stator part is the (inner part) stationary part of the fan. The rotor magnetic core is a closed slotted laminated silicon steel material, with copper or aluminium bars placed in the slots and short circuited on either end with copper or aluminium rings. (Here the aluminium bars or short circuit rings are of the pressure die cast type). The stator core fitted with a hollow shaft is also a laminated silicon steel core with a number of slots punched for placing the winding. The stator consists of two sets of winding, one set of the running winding and the other of the starting winding. There is a gauge difference of two numbers between the running and starting windings. Also, the resistance of the running winding is a little less than that of the starting winding. A capacitor is connected in series with the starting winding, hence both windings are connected in parallel with the supply terminals.

The starting winding is placed at 90° apart from the running winding. This

kind of phase displacement is required for developing the starting torque. The stator and rotor are assembled with aluminium enclosure. The rotator is fitted with bush bearings or bush and ball bearings or ball bearings on both ends. The whole assembly of the fan motor is fitted with a threaded G.I. pipe which is known as the "down rod" and the other end is suspended with a U-clamp and rubber shackle to the ceiling hook. The blades are fitted with their position by bolts or screws.

Equipment and Materials

(i) Continuity checker, test lamp, megger, ohmmeter.

(ii) Hidefaced hammer, ball pein hammer (250 gms) insulated combination pliers 150 mm, screwdriver 150 mm, connector screwdriver 75 mm, electricians knife, double ended spanner set in metric size, oil can.

(iii) Kerosene, grease, cleaning waste, smooth sandpaper, insulation tape and insulated sleeves (if need be).

Circuit Diagram

(i) Refer to the ceiling fan in Fig. No. 16.1(a).

(ii) Refer to circuit diagram of the internal connection of a ceiling fan in Fig. No. 16.1(b).

Procedure

(a) *Dismantling Procedure for a Ceiling Fan*

Once the ceiling fan is brought down from its fixed place onto the service table for study and dismantling, the following procedure is adopted:

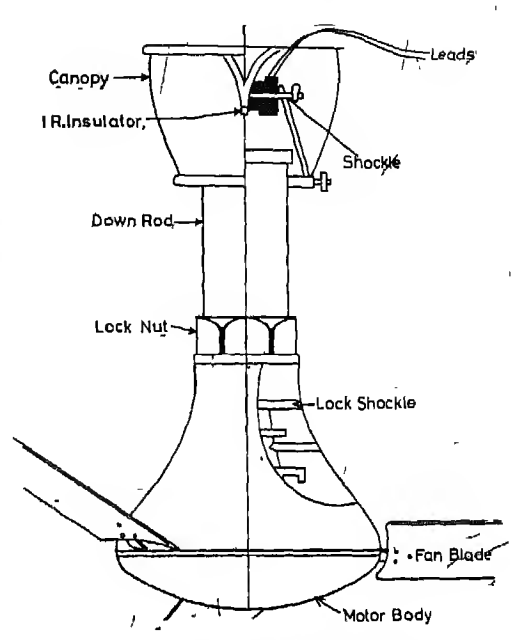

Fig. 16.1(a) With Resistance Type Regulator, Assembled Sectional View of a Ceiling Fan.

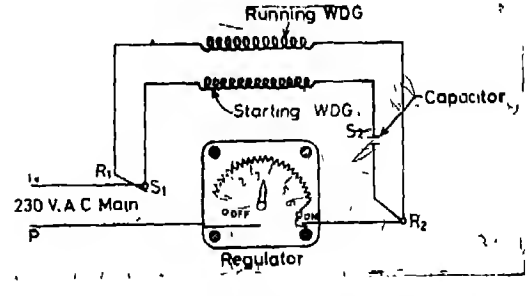

Fig. 16.1(b) Internal Connection Details of a Ceiling Fan with Regulator.

(i) The down rod of the fan is unscrewed after removing the lock pin (split pin). The lock screw is removed from the coupling and the

lock nut at the down rod end is to be loosened.

(ii) The fan blades are dismantled and the relevant screws may be fitted back in their position.

(iii) The cover screws are unscrewed and the grease cup or bearing cup screws are unscrewed; the external cups are preserved properly.

(iv) The stator and rotor assembly are dismantled by tapping with the hidefaced hammer, hitting slightly all around while holding the rotor shaft.

(v) The disassembled parts may be studied thoroughly for all the details of construction.

(vi) Having dismantled the ceiling fan motor for study and repairs, it is necessary to conduct the following tests and repairs if need be.

(b) *Testing*

The following basic tests are conducted to ascertain any defects and do the needful repairs accordingly. The tests are mainly the winding test, capacitor test, bearing test, defective regulator and connecting leads. The winding tests involves continuity check, resistance check, short or open circuit check, earth leakage check. The appropriate tests are done by using suitable instruments and readings are noted in a tabular form. Refer to Figs. 16.1 (c), (d) and (e) for the testing procedure. In case of any faults in the winding like open circuit, due to burning out of a coil or a set of coils or disconnection of coil and connection leads, necessary repairs are done. The capacitor condition may be checked as per the set procedure for open circuit, short circuit or leakage and any replacement required is to be done.

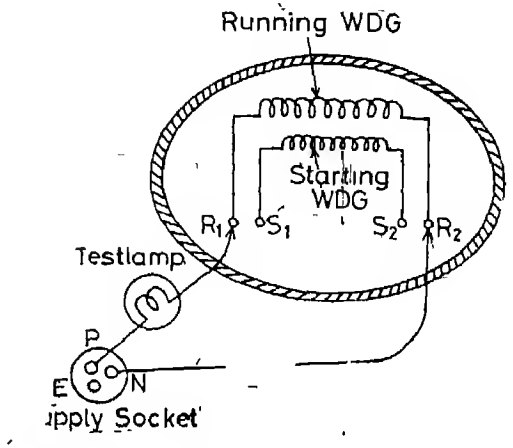

Fig. 16.1(c) Continuity Test for a Ceiling Fan.

The bearings are checked thoroughly and methodically for conditions like worn out, play, broken balls, etc, and any bearing that needs replacement must be charged. The regulator may also be checked for non-contact of regulated points, open resistor tapping points or choke or damaged resistors by testing with the series test lamp and necessary repairs or replacement may be done.

Similarly, the connecting leads are also checked for continuity and insulation and changed, if necessary.

(c) *Reassembling a Ceiling Fan*

The following logical procedure is adopted in assembling the ceiling fan.

(i) After thoroughly cleaning and drying apply proper grease to both

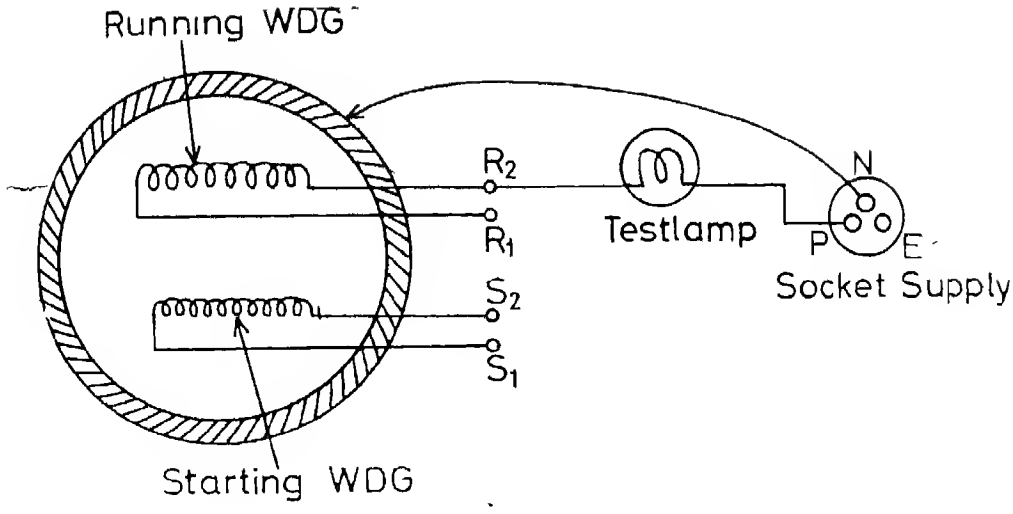

Fig. 16.1(d) Earth Leakage Test (Winding to Earth).

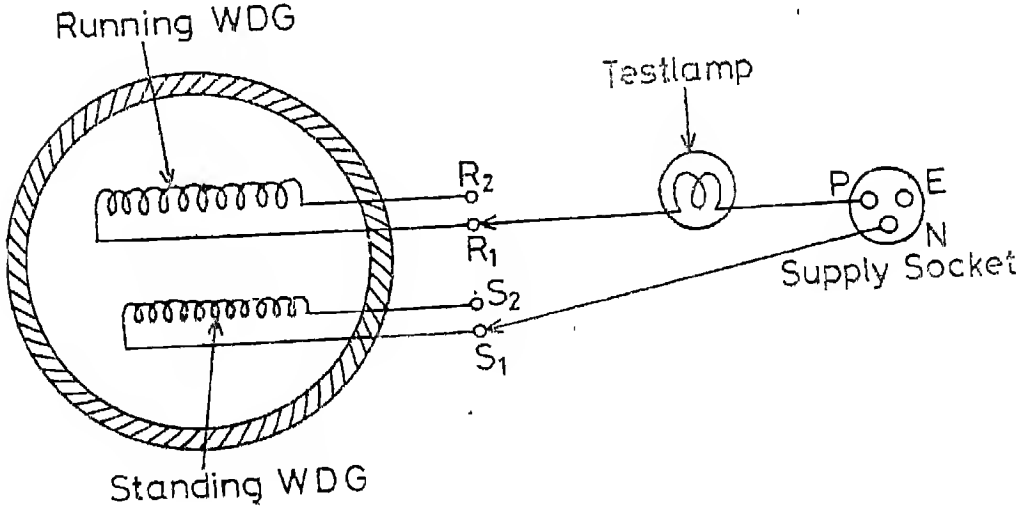

Fig. 16.1(e) Earth Leakage Test (Winding to Winding).

ball bearings.

(ii) The stator is placed in the rotator carefully and the supply leads are taken out through the hollow shaft.

(iii) The end covers on either side are fitted and a slight hit may also be necessary for proper seating.

(iv) Put the grease cups on both the ends and fix them with their screws.

(v) The capacitor is fixed in its clamp and the leads connected to the connector.

(vi) The coupling is fitted back, its back pin and lock screws are fitted properly.

(vii) The down rod is screwed into the other end coupling lock with the lock pin and lock nut.

(viii) The assembled form may be tested for its working before the blades are fixed and the fan refixed in its place.

Tabular Record of Observations

(a) Winding Test

Winding	*Continuity Test*	*Open Circuit*	*Short Circuit*	*Leakage if any*	*Resistance of Winding*	*Remarks*
Running winding						
Starting winding						

(b) Bearing Test

Bearing	*Type and No.*	*Condition of Outer Race*	*Condition of Inner Race*	*Condition of Balls*	*Play, if any*	*Remarks*
Top Bearing						
Bottom Bearing						

(c) Capacitor Test

Capacitor Volume	*Short*	*Open*	*Leak*	*Remarks*

Precautions

(i) Care must be taken while dismantling the fan motor as a hard hit may cause damage to the aluminium covers.

(ii) On dismantling the motor, the stator must be stored properly on a stand to prevent from any damage to the winding.

(iii) The ball bearings are to be protected by wrapping with butter paper to protect from dust and moisture.

Questions for Evaluation

State True or False in the brackets against each of the following sentences.

(i) An AC ceiling fan is fitted with four blades. ( )

(ii) A ceiling fan motor has two windings ( )

(iii) A ceiling fan motor is of the repulsion type ( )

(iv) The running winding in a ceiling fan motor will have high resistance ( )

(v) The capacitor is connected in series with the running winding ( )

(vi) The stator of a ceiling fan motor is of a solid circular wing ( )

(vii) The capacitor in a ceiling fan motor is not connected permanently in the circuit ( )

(viii) The phase displacement between the starting and running windings will be 90° ( )

(ix) The fan regulator is connected to vary the speed ( )

(x) The regulator is connected in parallel with the motor winding ( )

References

Electric Motor Repair Manual by Rosenberg.

Experiment No. 17

Title of Experiment

To study, test, dismantle and reassemble an exhaust fan.

Specific Objectives

(i) To study and test an exhaust fan.
(ii) To dismantle the exhaust fan.
(iii) To reassemble the exhaust fan.

Introductory Information and Related Theory

Exhaust fans are designed for installation above a window in the kitchen, dining hall and bathroom to remove unpleasant odour. They are extensively used in auditoriums, chemistry laboratories, etc. These are also called ventilation fans. In an auditorium, for example, the hat air exhaled by human beings goes up to the ceiling. This hot air is pushed up out by the exhaust fans and fresh air enters through the openings in the lower part of the building. A permanent capacitor type single phase induction motor is fixed in the exhaust fan.

Equipment and Materials

(i) Screwdriver
(ii) Nose pliers
(iii) Electrician's pliers
(iv) Spanners
(v) Electrician's cutter
(vi) Neon tester
(vii) Test lamp
(viii) Test board
(ix) Voltmeter 0-300 V
(x) Ammeter 0-5

Circuit Diagram

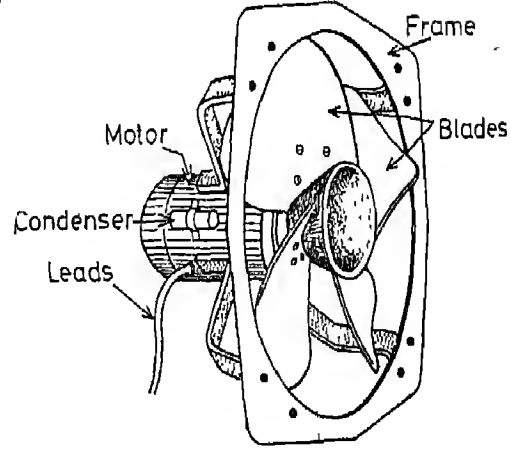

Fig. 17.1 Outside View of the Exhaust Fan

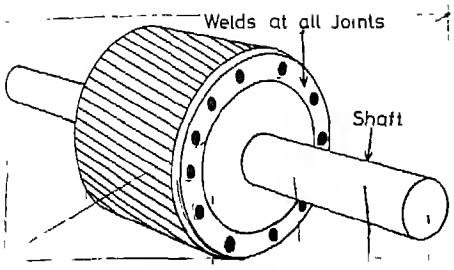

Fig. 17.2(a) Rotor of the Motor.

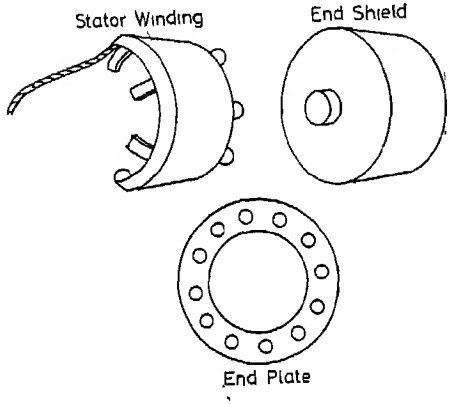

Fig. 17.2(b) Parts of the Motor.

Procedure

The various parts of an exhaust fan are:

(i) Main body
(ii) Stator
(iii) Running and starting windings
(iv) Rotor
(v) Blade

The exhaust fan shown in Fig. 17.1 is of modern design. The blades are dynamically balanced. The bushes are of the self-lubricating type.

Faults

In addition to electrical faults as discussed in the case of the table fan, ceiling fan and permanent capacitor motor, an exhaust fan can have the following mechanical faults.

(i) The bushes may be dry. This will be indicated by heavy running and hot bushes. The bushes can be cleaned with kerosene oil and then oiled with machine oil.
(ii) The fan blades may not be in one plane. This is indicated by the fan moving bodily on the table. This can be checked by positioning a pencil so that it is just touching one place. Now the blades of the fan are rotated. The other two blades should also just touch the pencil. If the blades are not in plane, they are to be corrected.
(iii) Worn out bush: This is indicated by the rotor touching the stator and, therefore, the fan gets hot due to the touching action. The worn out bush will require replacement.
(iv) Bent shaft: This is indicated by the fan blades touching the wire guard. The bent shaft is either straightened or replaced.

Dismantling the Exhaust Fan

(i) Remove the blade screw.
(ii) Take out the blade.
(iii) Remove the main motor body from the frame.
(iv) Remove the capacitor.
(v) Remove the back cover.
(vi) Remove the end cover.
(vii) Take out the rotor.
(viii) Take out the washers from the rotor.

(ix) Remove the bushes from the end plate.

After repairs and tests, the exhaust fan should be assembled in the following sequence.

Assembling the Exhaust Fan

(i) Fix the bushes in the end plate.
(ii) Fix the washers in the rotor.
(iii) Fix the rotor in the stator.
(iv) Fix the end plate.
(v) Fix the back cover.
(vi) Fix the capacitor in the proper place.
(vii) Fix the motor in the frame.
(viii) Fix the blade in the rotor shaft.
(ix) Finally, check the loosened screws and bolts.

Precautions

(i) Remove the exhaust fan after the terminals have been disconnected.
(ii) Do not hammer the blades to get them in one plane.
(iii) Use the proper spanner to remove the nuts.
(iv) Do not change the winding terminals.

Maintenance

(i) Lubricate the motor, if necessary.
(ii) Check the speed and sound.
(iii) Clean and remove dust every six months.

Questions for Evaluation

(i) What type of motor is used in an exhaust fan?
(ii) What is the purpose of an exhaust fan?
(iii) What will happen if the blades get out of balance in an exhaust fan?
(iv) How will you rectify it?
(v) What will happen if the condensor of the fan becomes defective?
(vi) Is there any regulator to control the speed of the exhaust fan?
(vii) Where will you fix the exhaust fan?
(viii) What happens if the direction of rotation is changed?

References

(i) *Home Appliance Servicing* by Edwin P. Anderson.
(ii) *Electrical Appliance Repair and Maintenance* by K. Nath.

Experiment No. 18

Title of Experiment

To study, test, dismantle and reassemble a pump motor.

Specific Objectives

(i) To study and test a pump set.
(ii) To dismantle the pump set.
(iii) To assemble the pump set.

Introductory Information and Related Theory

The domestic pump set used in houses employs a fractional horse power capacitor start single phase induction motor coupled to a centrifugal pump. The pump, when driven by the motor, lifts the water from the well to a water tank at the top of the building. The taps in the house are connected to the water tank through pipe lines.

The centrifugal pump raises the water from a lower to a higher level by creating the required pressure by means of centrifugal force. In its simplest form, it consists of an "Impeller" rotating in a casing as shown in Fig. 18.1. The casing is connected to a suction pipe at one side and a delivery pipe at the other. Before starting the pump, it is necessary that a portion of the delivery pipe is filled with water. This is called "Priming" of the pump. When the impeller starts rotating, it reduces the pressure at the eye of the impeller. This causes the water in the suction pipe into the eye of the impeller and water gets in between the vanes. Rapid rotation of the impeller sets up a centrifugal force and forces the water outwards, against the casing, through the delivery pipe to a higher level.

A foot valve is connected to the lower end of the suction pipe and it allows water in one direction only. This prevents the pump getting clogged with foreign materials and eliminates the need for priming the pump after a shut down as it holds water in the suction pipe.

To check whether priming is sufficient, an air cock is provided at the top of the casing. This air cock is opened and water is powered through the delivery pipe. The entrapped air is forced out of the casing and vanes by the water

and once the water fills the casing fully, the water starts gushing out through the air cock showing that priming is over. Then the air cock is closed.

Parts of Centrifugal Pump

The pump consists of a spiral volume form of casing which acts as a collector for the fluid discharged by the impeller. This is made into two halves and fixed together by bolts and nuts with a gasket placed between them. The impeller used is of the closed type i.e. the vanes are enclosed in shrouds as shown in Fig. 18.2. The impeller is fixed to the shaft and the shaft is held in position by bearings. Grease cups are provided for lubrication. A gland is provided to avoid air getting into the casing. The gland is packed with a thread and must be adjusted so that the leakage of water from the casing is not heavy.

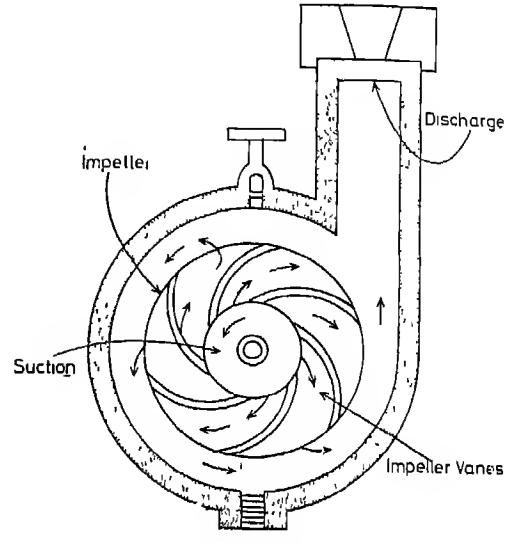

Fig. 18.1 Sectional View of the Centrifugal Pump.

Installation

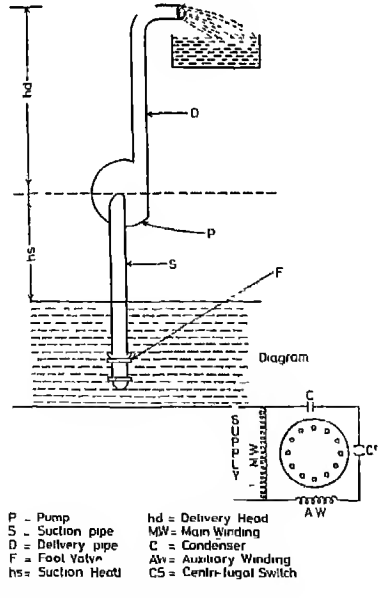

Fig. 18.2 Installation of Pump Set.

The pump must be fixed on rigid foundation using foundation bolts. Concrete foundations are usually employed because of their low cost, strength and appearance.

Equipment and Materials

(i) Spanner set (complete size).
(ii) Monkey spanner.
(iii) Hammer.
(iv) Puller.
(v) Pipe wrench.
(vi) Screwdriver.
(vii) Cutting pliers.

Diagram

Procedure of Dismantling

(i) Remove the connection from the terminal.
(ii) Remove the coupling of the delivery and suction pipe.
(iii) Remove the coupling.
(iv) Remove the impeller.
(v) Remove the motor.
(vi) Remove the casing nuts and bolts.
(vii) Make it into two halves.
(viii) Remove the threads.

For the motor, the procedure of the single phase capacitor start motor should be followed.

Procedure for Assembling the Pump

After cleaning the pump for the assembling, the following sequence should be followed:

(i) Fix the threads in the impeller.
(ii) Join the two halves of the impeller with the bolts and nuts.
(iii) Fix the motor in the foundation.
(iv) Fix the impeller, coupled with the motor on the foundation.
(v) Fix the suction pipe with the impeller.
(vi) Fix the delivery pipe with the impeller.
(vii) Give the electric connection to the motor.

Troubleshooting in Centrifugal Pump (Domestic Pumps Using FHP Motor)

S.No.	*Symptom*	*Possible Causes*	*Remedy*
1	2	3	4
1.	No liquid is delivered	Suction pipe not submerged to the required level	Check whether the suction pipe is submerged sufficiently, at least 5m below minimum water level.
		Lack of prime	Prime the pump
		Speed of pump driver too low	Check the motor speed and supply voltage. Low voltage may be the cause.

1	2	3	4
		Discharge head too high	Check whether all valves in the discharge line are wide open. If they are not open, open them. If the discharge head is still too high, check for blocking in the pipe line.
		Suction lift too high	Check the pump inlet for clogging by mud or some other obstruction. Check for broken discs in the foot valve.
		Impeller plugged	Sediment may accumulate on the impeller preventing it from discharging liquid. Open the casing and clean all the parts of the impeller.
		Wrong direction of rotation	Check the direction of rotation and change it, if necessary.
2.	Not enough liquid is delivered (i.e.) pump delivers liquid but not to the rated capacity.	Air leaks	Check the suction line or pump stuffing boxes for leakage, plug all leakage found in suction piping. The shifting box serving as the pressure side of the main shaft should leak a small amount of water. Adjust the gland, if necessary to give a suitable leak. If the leak is more, check the packing.
		Damaged impeller	Remove casing and inspect the impeller. Replace with a new one if vanes or other parts are damaged or worn.

1	2	3	4
		Foot valve partially clogged	Clean the foot valve and use
3.	Pump discharge pressure low	Air in liquid	Check whether the suction pipe is submerged sufficiently i.e. at least .5m below minimum water level
		Pump water passages obstructed	Open the casing and check whether the water passages are free. Remove any obstructions.
		Speed of pump too low and incorrect direction of rotation	Check line voltage and direction of rotation.
		Bearing rings worn	Replace the rings
		Impeller damaged	Check the impeller and replace, if necessary.
		Casing gasket defective	Replace the gasket.
4.	Pump loses prime after starting	Air in liquid suction pipe not sufficiently submerged	Check whether the suction pipe is submerged sufficiently
		Suction lift too high	Reduce suction lift.
		Air pocket in suction line	Check the suction line for leakage.
		Air leakage into pump through stuffing box	Check the stuffing box for water leakage.
		Water seal pipe is plugged	Check the water seal pipe.
5.	Pump overloads the motor	Discharge head low	With too low discharge head, the pump delivers too much liquid, overloading the driver. Use a lower capacity pump, if necessary.

1	3	4
	Speed too high and wrong direction of rotation	Check the applied voltage and direction of rotation.
	Packing too tight	Release the gland pressure then re-tighten reasonably. Check the leakage.
	Distorted casing	Poorly aligned suction and discharge piping can distort the pump casing, causing excessive friction between the impeller and casing. Check the piping and drive alignment. Inspect for work wearing rings.
	Bent shaft	Check with a dial gauge. Replace, if necessary.
	Mechanical failures	These can increase the drag on shaft, raising the power input. Check all rotating and stationary parts for failure, including the bearings, packing gland, bushing and impeller. Replace, as necessary.
	Pump speed too high	Power input to motor increases. Check the applied voltage.
Stuffing box over-heating	Packing is too tight or improperly installed.	Check the packing and rearrange it properly. Realign the pump.
	Bent shaft	Correct the shaft.
	Failure to provide cooling water.	Adjust the gland.

1	2	3	4
7.	Excessive vibration	Misalignment	Realign the pump properly.
		Worn or loose bearings	Replace the bearing
		Plugged or damaged impeller	Clean it or replace it, as necessary.
		Bent shaft	Correct the shaft
		Rotor out of balance	Balance the rotor properly.
		Non-rigid foundation	Put a rigid concrete foundation.
8.	Bearings have short life.	Misalignment. Bent shaft, worn bearings. Rotor out of balance. Mechanical failures inside the pump.	Realign the pump properly. Replace the worn bearing.
		Excessive amount of grease in bearing. Lack of lubrication.	Lubricate properly according to manufacturers recommendation.
		Dirt getting into bearings. Rusting of bearing due to water getting into it.	Seal the bearing from dirt or water.
9.	Pump gets heated and seizes	Pump not primed	Re-prime the pump.
		Operation at very low capacity	Never operate it at very low capacity.
		Misalignment. Rotating part rubbing on stationary part. Misalignment. Worn bearings. Rotor out of balance Mechanical failure inside the pump.	Realign the pump properly. Replace the worn bearing.

Maintenance

(i) Check the grease box often and fill it.

(ii) Do not run the motor when there is some mechanical trouble in the impeller.

(iii) Clean the dirt often.

Precautions

(i) Before you switch on the motor, check the voltage.

(ii) Do not run the motor without priming.

(iii) Before attending to any repairs in the switchboard, insulate yourself well.

Questions for Evaluation

(i) What is known as the suction head of a pump?

(ii) What is known as the delivery head of a pump?

(iii) What is the necessity of the foot valve?

(iv) What is priming?

(v) What is the purpose of a gland? Why is the gland packed with a thread?

Reference

Pump Generation and Maintenance by Hichs.

Experiment No. 19

Title of Experiment

To study, test, dismantle and reassemble an electric mixer.

Specific Objectives

To acquire skill in the testing, dismantling, reassembling, maintenance and repair of an electric mixer for domestic use.

Introductory Information and Related Theory

An electric mixer is one of the most useful domestic appliances. It is also called a liquidiser, mixi and food grinder. It is used to grind fruits, coffee seeds, nuts and to prepare delicious creamy, smooth milk shakes, butter milk or other drinks, etc. It mostly consists of an A.C./D.C. motor of high speed (15000 to 20000 R.P.M.) connected with a switch and supply leads fixed in the bottom bowl. The motor is fixed in such a way that its shaft is brought out vertically in the top bowl with which the blade is fixed to mix the liquid products or to grind the fruits, etc. The two bowls are set in such a way that even a drop of water cannot pass through the shaft and enter the bottom bowl. If this happens, it means the mixer has become defective and motor gets damaged very soon. The top bowl is covered with a top cover. A handle is fixed on the side of the top bowl for convenient use. The upper bowl is made of thick transparent glass to enable the mixed material to be seen easily. The upper bowl is set on the coupling, fixed to the lower bowl and is removed easily.

An electric mixer is operated in the following way:

Different fruits or liquid products are put in the top bowl and covered with the top cover. The supply plug is connected with the supply and switched on. Then the switch of the motor is turned 'on' and the motor works at high speed. The blade attached with the shaft moves fast and grinds the fruits and mixes the liquid products. The speed of the motor can be controlled with the switch knob. Before pouring out the mixed products, the supply is switched 'off' first.

To grind solids, a special type of blades with separate bowls are attached to the motor shaft, after removing the original bowl.

Materials and Tools Required

(i) Insulated combination pliers.
(ii) Insulated long nose pliers.
(iii) Line tester.
(iv) Common screwdriver.
(v) Test lamp (40 W).
(vi) Testing loads 3/22 SWG copper wire.
(vii) Small hammer
(viii) Mixer for dismantling, reassembling and testing.

Mixer Parts

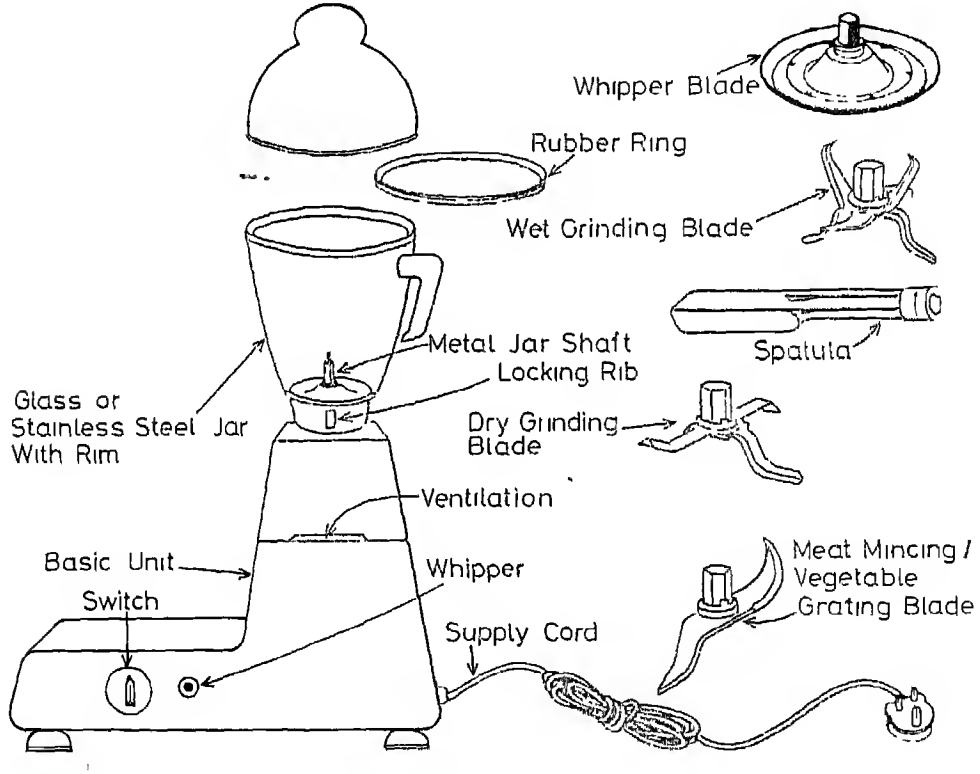

Fig. 19.1 Mixer and its Parts.

Procedure for Testing and Repairing

By switching on the supply, if the shaft of the motor does not rotate, check the supply, supply leads, connection at the switch and connection at the motor terminals and also test the continuity of the motor with the help of a series test lamp. If the connections are broken, connect

them. If the motor is defective, repair it according to the repairing procedure given in the experiment on repairing a small motor, or replace the motor.

If the top bowl leaks, set it properly with leak proof insulation.

If the blades are broken, replace them.

If the switch knob is loose, tighten it properly.

If the motor has burnt out, get it rewound or replace it.

If the blade does not rotate properly (freely), reduce the load.

Observations

Some Common Faults in a Kitchen Mixer/Dry Grinder

S.No.	*Symptom*	*Possible Causes*	*Remedy*
1	2	3	4
1	Motor does not rotate	1. No supply in the socket	1. Check the supply in the socket.
		2. On/off switch not working	2. Check and replace the defective switch.
		3. Disconnection at the lead plug	3. Check the lead, replace if broken, tighten the plug pins if loose.
		4. Open circuit field	4. Check the field coils for open circuit. Measure the resistance of each and compare.
		5. Open circuit in armature	5. Check the armature for open, shorted or earthed winding.
		6. Worn out brushes	6. Check brushes and replace if worn out.
		7. Brush springs sucking	7. Remove the brushes, check the spring for rust sucking in holders for loss of tension, replace if defective.

1	2	3	4
2.	Motor operates but does not grind.	Motor R P.M. is low. Blades broken a loose on the shaft, no supply voltage. Worn out brushes, dirty commutator, shorted commutator, shorted winding	Check the motor for excessive friction and oil if hard in rotation. Check the blades for tightness in the shaft. Check supply voltage. Clean Commutator. Replace brushes if necessary. Wind motor if required.
		Shorted field coil, worn brushes, commutator defective, winding defective.	Check and replace brushes or spring if required. Clean the commutator, polish the brushes or clean commutator. Check commutator segment for shorting.
3.	Defective armature	Check the armature	Rectify/replace, if necessary
4.	Defective field coils	Open and check for earthing, shorted coil or open circuit, wrong connections	Check the armature winding for short or open. Check field coils. Check the armature if rubbing with shoes. Change commutator and rewinding armature, reconnect. Check and measure the resistance of each coil and compare. Check and correct connections.

Precautions

(i) The motor should not be used continuously for more than the prescribed time. There should be a gap of one minute between each operation.

(ii) Do not insert any metal part from the centre stopper when the motor is in motion.

(iii) Do not put big pieces while making cold drinks. Crush ice and then put into the blender.

(iv) Boiling liquids must not be put in the liquidiser.

(v) When the motor is in operation, do not remove the grinder.

(vi) Only two-third of the bowl should be filled for mixing.

(vii) Don't attempt any repair when the mixer is connected with the line.

Questions

(i) What type of motor is used for a mixer?

(ii) What is the range of speed of a mixer motor?

(iii) Explain the principle of working of a mixer?

(iv) What are the possible faults of a mixer and what are the remedies for them?

(v) Explain the method of cleaning the blender and grinder.

Experiment No. 20

Title of Experiment

To study, test, dismantle and reassemble an electric hair drier.

Specific Objectives

After the completion of this practical exercise, the trainee should be able to:

(i) Test the hair drier for satisfactory performance.

(ii) Dismantle, take out the various components, check the performance and function of each

(iii) Reassemble after necessary repairs.

Introductory Information and Related Theory

Nowadays the use of hair drier is becoming very common amongst the ladies. Hair driers are used for drying the hair quickly. They are also used for drying paint and photographic material, etc.

A hair drier consists of a 220 V, A.C./D.C. universal/synchronous motor of about 40 W having a P.V.C. disc with fins or a metal disc with blades on the front side and a heater element of about 25 W in front of the fan. There are two toggle/sliding switches for the individual control of the motor and the heater The entire unit is placed in P.V.C. moulded casing having a grill on the back side for the inlet of fresh air and an outlet on the front for blowing out the air. When the hair drier is connected with the supply mains and switched on, the fan motor starts and air passes through the heater, warms up and blows out.

Some of the driers are provided with a 3-positioned switch, Hot-Cold-Off (two-way and off switch) instead of two individual switches.

Equipment and Materials

(i) Hair driers, 220 V AC/DC mains operated.

(ii) Insulated combination pliers 15 cms.

(iii) Screwdrivers 15 cms and 10 cms.

(iv) Screwdrivers 15 cms and 10 cms, Philips type.

(v) Tweezers, 10 and 15 cms.

(vi) Soldering iron 230 V, 60 W.

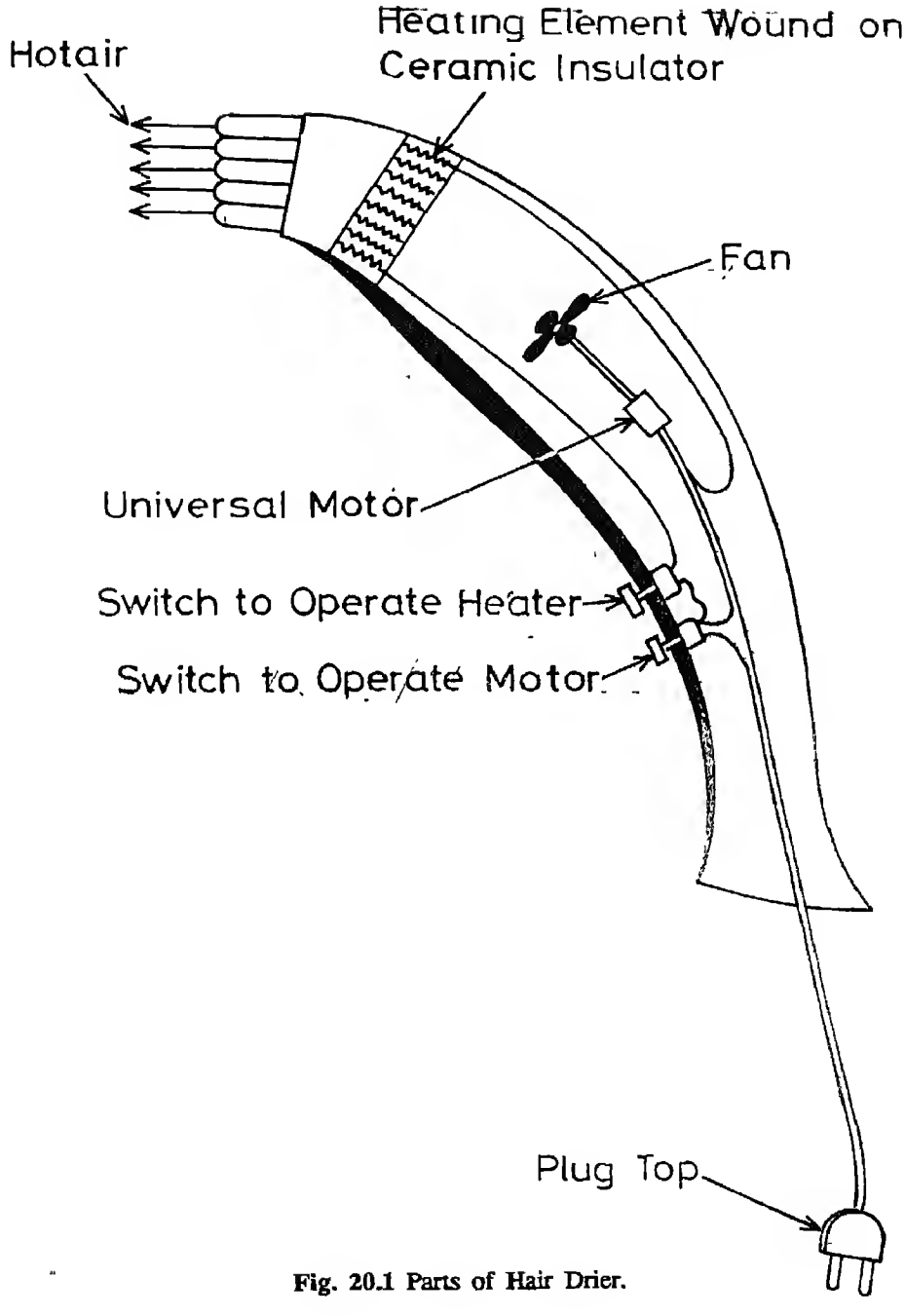

Fig. 20.1 Parts of Hair Drier.

(vii) Soldering flux.
(viii) Soldering wire resin cored.
(ix) Test lamp.
(x) Multimeter/AVO meter.
(xi) P.V.C. sheathed/cotton braided flexible cord 2-core/3-core.
(xii) Plug top, 230 V, 5 Amps. 2-pin/3-pin.
(xiii) Heating element of the required size, shape, voltage and wattage.
(xiv) Set of carbon brushes of the required type, size and shape.

Circuit Diagram

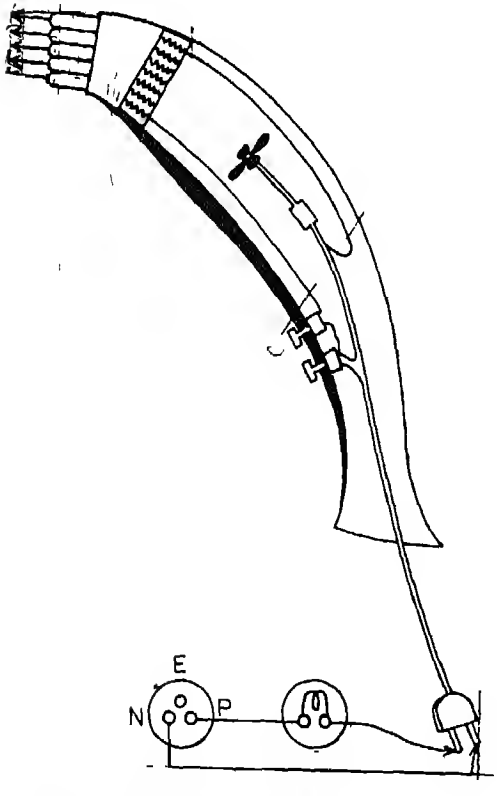

Fig. 20.2 Continuity/Short Circuit Test on Hair Drier.

Procedure

(a) If the fan motor doesn't start, then:
(i) Check the supply in the wall socket.
(ii) Test the cord for continuity/short circuit.
(iii) Check the proper function of the switch/switches by a test lamp/ multimeter/AVO meter.
(iv) Check the proper setting of the carbon brushes.
(v) Check the continuiy of the connecting leads/wires provided in the fan motor's circuit.
(vi) Check and see, by giving manual rotation to the rotor, that it is not locked up and is free to rotate.
(vii) Check the commutator and if found carbonized, clean it with smooth emery paper.
(viii) If still no fault is located, it means the fault lies in the windings for which the drier may be sent to a highly skilled winder.
(b) Open fault in the heater circuit. To locate this fault:
(i) Check the leads/wires connecting the heater element.
(ii) Check the switch placed in the heater circuit for its proper functioning and if found defective, replace.
(iii) Check the heating element for its continuity/short circuit as explained in practical exercise No. 7 on "To test and repair an electric soldering iron".

Tabular Records of Observations

Test for Continuity/short Circuit Test on Heating Element

	Lamp	*Multimeter Reading*
Open circuit	No light	Infinity
Short circuit	Bright	Zero
Perfect	Dim	Records resistance

Precautions

(i) See that all the wire connections are properly tightened.
(ii) Ensure the proper functioning of the switches.
(iii) Ensure the proper setting of the carbon brushes.
(iv) Clean the surface of the commutator if found dirty.
(v) Never patch the resistance of the heating element.
(vi) While testing, first switch 'on' the fan motor, then the heater and never vice-versa.
(vii) If a particular model of the hair drier has been taken up for the first time, spend some time to study its fitting, all the parts and their functions.
(viii) Before dismantling the drier, first try to learn the cause of failure from outside.
(ix) Ensure the proper earth connection when a 3-core cord used.

Questions for Evaluation

(i) Why is it essential to first start the fan motor and then the heater?
(ii) What are the common faults in a hair drier when it doesn't give hot air?
(iii) What portions would draw your attention when the fan motor does not start?

Reference

Study of Electrical Appliances and Devices by K.D. Bhatia.

Experiment No. 21

Title of Experiment

To study and test, dismantle and reassemble a washing machine.

Specific Objectives

(i) To study and test a washing machine.

(ii) To know the method of its operation.

(iii) To dismantle the washing machine.

(iv) To assemble the washing machine.

Introductory Information and Related Theory

Washing machines carry out all the washing techniques like soaking clothes, applying soap, rinsing, etc. Washing machines are classified as follows:

(1) Automatic type
   (a) Agitator type
   (b) Cylinder type (or) Tumbler type

(2) Conventional type
   (a) Wringer type
   (b) Twin tube washer

The agitator type washing machine is shown in Fig. No. 21.1. In this, an agitator is provided within a tub and clothes are loaded from the top. Water mixed with soap is provided in the tub. The agitator is driven by the agitator drive. There are various types of agitators. The agitator oscillates in the tub. This forces soap water through the pores in the clothes, thus, flushing out the dirt. The soap water is then drained out and fresh water is let in to the rinse the clothes. The water is changed again and the process of rinsing is repeated till the clothes are free of soap water. Then the water is drained and the drum is rotated at a high speed. This removes the water from the wet clothes. The clothes are then sent for final drying and ironing.

The drive for the washer is provided by a capacitor type split phase motor and connected mechanism. A heater is sometimes added to help the soap to dissolve easily in the water and a pump is also added for emptying the tub.

The tub is made of aluminium, copper, enamelled steel or fibre glass.

The automatic tumbler type machines are usually connected to the water supply. Some models are fixed on the

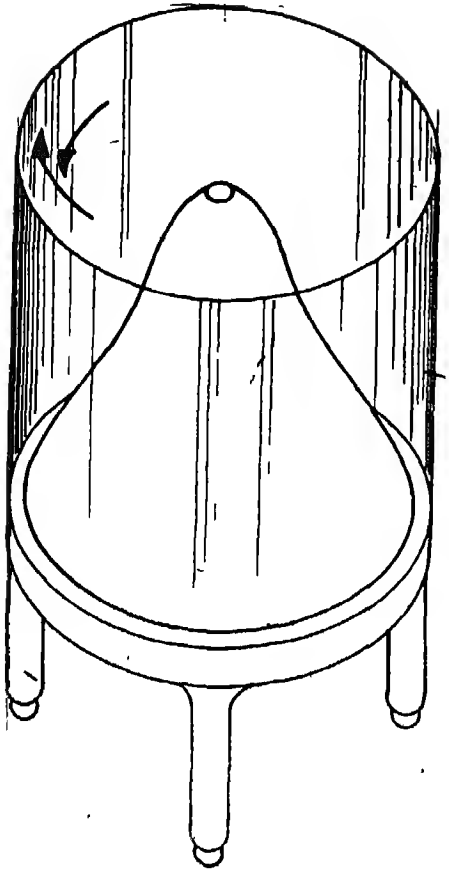

Fig. 21.1 Agitator Type Washing Machine.

floor (Fig. 21.2.) The clothes are put through a door that opens in the front. They soak, wash, rinse and extract water. They need no attention except the addition of soap water when the drum stops after soaking. The cylindrical basket rotates in a horizontal plane. Agitation of clothes occurs by lifting them out of the soapy water and letting them fall back into the water due to their own weight as they reach the top of the revolution. A 2-KW heater is sometimes used to increase the temperature of the water during the wash periods. After each washing operation, the tumbler will extract moisture by spinning the drum with the wet clothes.

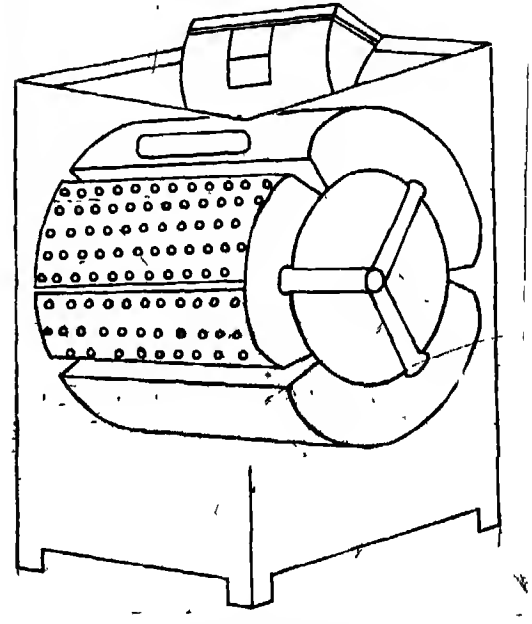

Fig. 21.2 Tumbler Type Washing Machine.

The cylinder basket revolves slowly (about 50 RPM) during the wash and rinse periods, at the end of which the water is drained from the machine. The cylinder basket then revolves much faster (600 RPM) for normal action and 300 RPM for gentle action to spin the clothes damp dry and ready for final drying.

Because there is no agitator in a tumbler washer, the construction tends to be

somewhat simpler, requiring only a means to spin the cylinder basket at three different speeds.

Details of Operation of an Automatic Washing Machine

An automatic washing machine is a complicated piece of machinery because it is required to perform many functions in the course of a complete washing cycle.

First, the customer selects the quantity and desired temperature of the water to be used. The detergent is added to the proper receptacle or placed directly into the machine. Then a button is pushed or a dial is turned, causing the machine to take over and begin the washing. The machine closes the circuits of the driver and timer motor. The drive motor is coupled to (1) the agitator in the agitator type washing machines and to the drum in the tumbler type washing machine; and (2) a water pump. The timer motor controls the operation of the machine during the entire wash and spin cycles.

The cutomer selects various fill levels like high, medium or low, depending on the wash to be done, by turning a knob. The knob operates a pressure switch or a float switch which is pre-set to open when the proper level is reached. In the same manner selection of hot, warm or cold wash water involves opening or closing the water inlet valves by means of solenoids.

When the fill switch is in control, the agitator cannot function until the machine is filled with water to the proper level. Once it is filled to the proper level, a separate mechanism operates a solenoid. This operates a mechanical system and causes the drive clutch to engage and the agitator begins to oscillate, and the tumbler basket begins to revolve in the wash cycle.

After the wash cycle, the timer motor closes another switch through a cam arrangement. This energizes a solenoid valve to open and drain the tub. A short spin cycle follows to remove any dirt that may remain in the tub. A spray cycle after this helps in the above process. During the spray cycle, the outlet valve remains open so that the water admitted drains out immediately. The timer motor now advances another cam surface to close the switch controlling the water inlet valve, at the same time opening the circuit to the drive solenoid causing the cylinder basket to come to a stop. After a brief pause, the timer motor closes the fill switch and the tub fills with water again.

The deep rinsing cycle follows. This is for a brief period and is accompanied by short period of agitation. At its conclusion, all motion of the cylinder basket or agitator again comes to a stop and the tub empties.

The washing machine now goes into the final rinse and spin dry cycle. The final rinsing may consist of a spin, accompanied by one or two spray rinses, the purpose of which is to disclose through the holes in the cylinder basket,

any dirt or soap which may have been deposited on the surface of the clothes as the water level receded during the drain cycle. After the last spary rinse, the cylinder basket continues to spin at a high speed for a few minutes during which most of the water is driven out of the clothes by the centrifugal force of the spin.

Finally, the timer motor advances to a point where all circuits are opened and the washing machine shuts itself 'off'

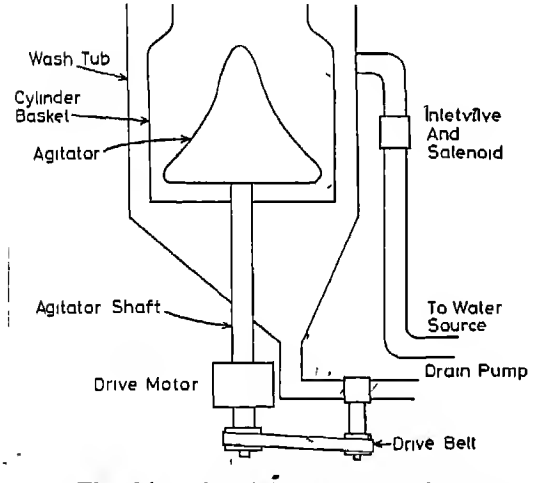

Fig. 21.3 Pictorial View of Agitator Type Washing Machine.

Equipment and Materials

(i) 30 cm Screwdriver.
(ii) Electrician's pliers.
(iii) Spanner set.
(iv) Hammer.
(v) Mallet.
(vi) Brush.
(vii) Nose pliers.
(viii) Pillar.
(ix) Voltmeter 0-300-V.
(x) Ammeter 0-5 ampere.
(xi) Washing machine.

How to repair a washing machine

The common complaints in a washing machine and the likely faults are given below:

(i) *Failure to start*
If there is no sound from the machine, check the A.C. supply circuit. If the motor burns, the fault is either in the motor or in the mechanical assembly.

(ii) *Does not wash*
The probable fault is in the agitator mechanism and connected drive.

(iii) *Slow operation*
Overloading or binding or defect in the drive mechanism.

(iv) *Leaks*
These can be easily traced in their origin.

(v) *Does not wash clean*
Improper operation by the customer.

(vi) *Tears clothes.*
Improper adjustment of the agitator or by the worn bearing.

(vii) *Soils clothes*
Oil leaks into the wash water.

Maintenance

When not in use;

(i) Thoroughly dry all accessible parts, particularly the area and rubber rim near the top of the machine.
(ii) Clamp hose pipe in the proper place.
(iii) Fold back wringer.

(iv) Replace the top.
(v) Wheel to a convenient place.

When it is in use:

(i) Lubricate the agitator shaft by SAE 30 motor oil.
(ii) Lubricate the motor through the oiling points.
(iii) Adjust the 'V' belt when it is loose.

	Do		*Don't*
1.	Use SAE motor oil as lubricant	1.	Use of vegetable oil will damage the bearing
2.	Adjust 'V' belt once in 3 months	2.	Over tightened 'V' belt will damage the bearings.
3.	Put the water before switching on the heater	3	Switching on the heater without water will damage the washing tub.
4.	Sort out clothes according to fabric and colour	4.	Mixed coloured clothes will get spoiled due to colour diffusion.
5.	Let synthetic clothes drip dry	5.	Pass through wringer
6.	Fill water up to marking 'Water level'.	6.	Overflowing water may damage motor.
7.	Use detergent in hard water	7.	Soap will not give lather.
8.	Put the recommended load of clothes	8.	Overloading will stop the rotation of clothes, hence no washing will take place.

Troubleshooting

S.No	*Problem*	*Reasons*	*Repair or Remedy*
1	2	3	4
1.	Washing machine does not fill with water after operating the switch	1. Water valves on pipes closed	Open valves
		2 Water inlet hose bent	Straighten out hose.
		3. Clogged water in-take screws	Screws are located in the hose connection. Remove screws and remove sediment.
		4. Defective water valve	Disassemble water valve and inspect parts for damage. Replace a bad part with a new one, if possible. If not, replace the entire valve.

1	2	3	4
2.	Washing machine does not wash	1. Broken drive belt	Replace with new belt
		2. Drive belt is too loose and slips	Tighten. The correct belt tension is attained when the belt can be deflected 1/2 inch (1.27 cms).
		3. Defective transmission	Place control knob in 'Wash' position. Remove the drive belt and turn the transmission pulley by hand in the direction of agitation which is generally clock-wise. If the agitator is not driven by this action, the transmission is probably bad and should be over-hauled or repaired.
		4. Open circuit	With control knob at 'Wash' position, probe each wire connection with a test lamp to find out if there is a defective wire or loose connection.
3	Motor does not operate	1. No power supply	1. Make sure that the power cord is plugged into the wall socket.
		2. Blown fuse	2. Repair fuse
		3. Defective motor	(Already explained in the chapter on fraction horse power motor). Most washing machines are protected by an internal overload circuit breaker which turns the appliance off if the motor overheats.

1	2	3	4
			If the motor cannot be started, thirty minutes later this protective part turns the motor off. The reason for the problem may not be the motor but clutch or transmission. To determine if this is the case, remove the drive belts, set the control knob at 'wash' position and turn on the machine. If the motor operates, there is no motor problem. Isolate the problem to the clutch or transmission.
4.	Water does not drain out	1. Bent drain hose	Straighten out hose.
		2. Broken drive belt	Replace with new belt
		3. Slipping drive belt	Tighten belt. The correct belt tension is attained when the belt can be deflected (1/2 inch) 1.27 cms.
		4. Clogged drain	Free drain.

Questions for Evaluation

(i) How are washing machines classified?
(ii) What are the two types of conventional washing machines?
(iii) What are the two types of automatic washing machines?
(iv) Why is a heater used in some washing machines?
(v) What are the two types of driers used in practice?
(vi) What is a rotary ironer?
(vii) What is a wringer?
(viii) Mention three common faults in washing machine?

References

(i) *How to Repair Major Appliances* by Trnest Tricomi.
(ii) *Household Electricity* by Mery George.

Experiment No. 22

Title of Experiment

Estimating and costing.

Specific Objectives

(i) To understand and estimate the details of repairs.

(ii) To possess knowledge regarding costing for repairs.

Introductory Information and Related Theory

Servicing of domestic appliances/repair of interior wiring is a specialized job in small towns or big cities. In domestic appliances manufactured by various manufactures with different brand names the operating part or the constructional features may differ but the principle of working remains the same. For the person who establishes a repair shop to cater to the public's needs, his reputation as a repair man is important. It is, therefore, necessary to concentrate on a few types of appliances of prominent makes, so that the service personnel may make good profit of earning and also establish a good reputation. The reputation rests on the quality of work done, the quality of spares used and the cost of repairs with sufficient guarantee on the repairs done.

Also, the correct approach to repair work is necessary. Assessing the job for repairs and reasonable costing is an important factor in the market. The repair man must have thorough knowledge of all the appliances and a sufficient stock of spares for replacement is essential. To carry out the repairs under able guidance, the supporting labour is necessary with all the prerequisites. As mentioned earlier, the estimate of repairs must be done on a thumb rule which simplifies matters for all purposes.

Based on the estimate of repairs to be carried out the appropriate cost of repairs also must be considered. The repair charges must be based on some fundamental principles, which should fetch a good profit for the repair organisation. The cost of repairs must be fair, reasonable and competitive.

Data/Particulars

(i) The details of the circuit diagram, operating instructions, and the sequence of operation of each and every appliance must be known first for identifying the trouble. Necessary references, if any, are to be collected from the customer.

(ii) The details of spares for replacement must be noted with complete specifications including any particular specifications/dimensions.

(iii) In case of domestic wiring installations, the details of main and sub-circuits and individual point controls are necessary for reference.

(b) *Details of Repairs*

Procedure

The approach to identify the trouble encountered must be logical. The procedure to be adopted to estimate the cost of repairs is given below:

Estimate of Repairs and Costing

(a) *Appliance Repair Card*:

Appliance name _____
Complaint _____
Name of customer _____
Address of customer _____
_____
_____
No. _____
Date of ref. receipt _____
Date of delivery _____
Phone No. _____

No.	*Details of Appliance*	*Nature of Trouble*	*Attended by*	*Time Taken for Repair*	*Spares Used*	*Observations After Repair*
1	2	3	4	5	6	7

On the basis of the data recorded above the actual cost of repair is worked out as outlined in the table given below:

(c) *Repair Cost*

S.No	*Details of Repairs*	*Rate*	*Quantity*	*Total Cost*	*Remarks*
1	2	3	4	5	6
1.	Cost of spares				
2.	Cost of materials				
3.	Service charges				
4.	Overheads if any				
5.	Sales tax + Surcharge				
	Grand Total.				

Profit should be added to the actual cost before billing it to the customer.

Precautions

(i) Due precautions are to be taken while assessing for repairs, dismantling or checking for any breakages.

(ii) Don't try to use any non-standard or improper size spares for replacement.

(iii) After the repairs are done, don't try to operate in extreme conditions of operation which may result in damage to the appliance.

Questions for Evaluation

(i) What basic principle should you adopt in estimating for repairs?

(ii) What simple procedure should you follow in identifying a fault in domestic wiring installation?

(iii) State a few safe measures that should be followed in doing repairs.

References

(i) *Electric Motor Repair Manual* by Rosenberg

(ii) *Small Appliance Servicing* by Brockwell.

Experiment No. 23

Title of Experiment

Organising a repair shop.

Specific Objectives

The student should be able to:

(i) draw the layout of repair shop.

(ii) to prepare list of equipment required and

(iii) to understand procedures for inventory records.

Introductory Information and Related Theory

To establish a domestic appliance repair shop, a few basic essential things are to be thought of i.e. the requisite area of the repair shop must be predetermined depending on the variety of appliances that are going to be serviced. Based on the initial requirement, necessary facilities must be made available for the convenience of carrying out the service job in an orderly manner. Depending on the specialization in the field of servicing chosen, the necessary testing equipment, service tools and appliances must be provided. In addition to the above facilities, it is also necessary to maintain the important records in terms of inventry of stock of stores, particulars of appliances being received from time to time for repairs, record of repairs done, spares replaced, costing repairs, etc.

While organising a service shop, it is also necessary to maintain the shop's reputation for the repairs done in keeping with high service aspects. Also a specific period of guarantee will be an additional advantage as it will attract more customers. The shop repair floor must be organized in such a way that appliances received for repairs are properly stocked in a storage place. The service area must be organized in a comfortable manner, and service tools kept in a convenient place for easy access. The testing area must be organized in a convenient place for proper testing. The serviced (repaired) appliances must be stored in a proper place for delivery. The necessary records of service are supposed to be preserved properly. Some of the costly testing instruments must

be kept in a safe place after use. As a whole, the systematically organized service shop must be made convenient in all respects.

Shop Layout for a Repair Shop

Tools and Equipments

A list of tools, equipment and instruments required to organize a repair shop is given at the end of this chapter.

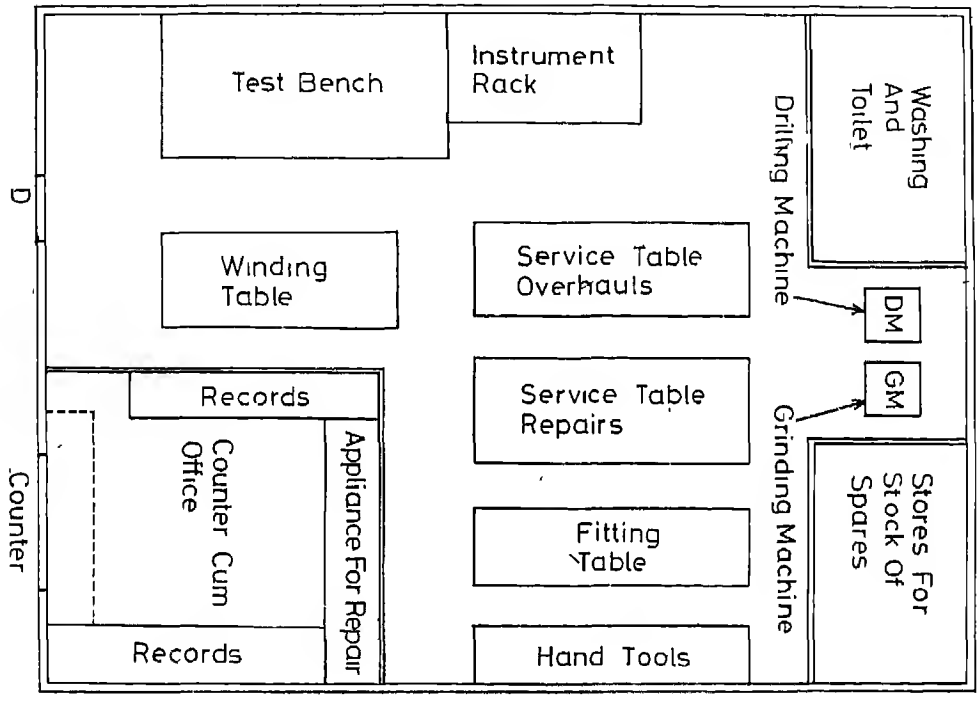

Fig. 23.1 A Layout of a Domestic Appliance Repair Shop.

A Common Specimen of Formats Used in the Repair Shop

JOB ORDER CARD

1. Name of the customer _____
2. Address _____
3. Appliance given for repair _____
4. Nature of trouble _____
5. Date of receipt _____
6. Date of delivery _____

The estimate of repair charges may be arrived at as follows:

The form mentioned below may be used. The nature of defects and repair charges may be intimated to the customer.

FORM OF ESTIMATE OF REPAIR CHARGES

1. Cost of spares to be replaced:
   (a) ..... Rs.....

(b) ..... Rs.....
(c) ..... Rs.....
(d) ..... Rs.....
Sales tax and surcharge.. Rs.....
2. Service charges ..... Rs.....

Total Rs.....

Note: The service charges include the labour cost, the profit margin and a percentage of expenses for maintaining the shop.

Experience in the business will show the way to arrive at the above expenses but, at the same time, it must be borne in mind that the rates must be competitive.

Safety

(i) A wooden plank or rubber mat must provided near the testing table.
(ii) Safety goggles must be provided near the grinding machine.
(iii) Some of the hand tools which are supposed to be insulated must be acquired.
(iv) Proper lighting in the repair shop is essential.

Questions for Evaluation

(i) What basic amenities are necessary to set up a domestic appliance repair shop?
(ii) Draw a shop layout for a domestic appliance repair shop.
(iii) What common service records are necessary to maintain the service shop?
(iv) List out a set of hand tools and test equipment required for a small service shop.

Reference

Small Appliance Servicing by Brockwell.

List of Hand Tools For a Domestic Appliance Repair Shop

Sl.No.	*Description*	*Quantity*
1	2	3
1.	Combination cutting pliers insulated : 200 mm.	2 Nos.
2.	Long nose pliers round insulated : 150 mm	2 Nos.
3.	Square nose pliers insulated : 150 mm	2 Nos.
4.	Grip wrench pliers : 200 mm	2 Nos.
5.	Bent nose pliers : 150 mm	2 Nos.
6.	Insulated stripper : 150 mm	1 No.
7.	Screwdriver set with neon lamp (Similar to BAHCO type)	2 set
8.	Insulated screwdriver plastic handle : 200 mm	2 Nos.
9.	Wire nipper : 150 mm	1 No.
10.	Screwdriver Set : 150 mm	1 No.
11.	Socket wrench type screwdriver (1/8" to 1/4") 3 mm to 6 mm	1 set each
12.	Allen key set of 3, 4, 5, 6, 7, 8, 9, 10, 12 and 15 mm.	1 set
13.	Tubular hacksaw : 300 mm	2 Nos.
14.	Magnet spanner set in inch and mm size	1 set each
15.	Tubular spanner set 6 x 7, 9 x 10, 12 x 13, 18 x 19, 25 x 18 and 30 x 32 with tonny bar	1 set
16.	Double ended open jaw chrome vanadium steel chrome plated spanners, a set consists of metric size 6 x 7, 8 x 9, 10 x 11, 12 x 13, 14 x 15 and 16 x 17 mm.	1 set
17.	Ball pein hammer drop forged type : 200 gms	2 Nos.
18.	Ball pein hammer drop forged type : 500 gms	2 Nos.
19.	Hide faced hammer 75 mm dia	2 Nos.
20.	Rubber hammer 75 mm dia	2 Nos.
21.	Plastic hammer 600 mm dia	2 Nos.

1	2	3
22.	Watch maker screwdriver	1 set
23.	Tweezers chromium plated 100, 150, 200, 250 mm.	1 No each
24.	Magnifying glass 100 mm dia to magnify 10 times	2 Nos.
25.	Feeler gauges in inch and matric	1 set
26.	Jeweller's files set	1 set
27.	Magnetic compass 17 mm dia.	2 Nos.
28	File knife edge 150 mm.	2 Nos.
29.	File smooth flat 150 mm	2 Nos.
30.	File triangular second cut 150-200 mm	2 Nos. each
31.	File rough flat, 150, 200, 250 and 300 mm.	2 Nos. each
32.	File rough smooth 150, 200 and 250 mm.	2 Nos. each
33.	File flat second cut 150, 200, 250 and 300 mm.	2 Nos. each
34.	File wood rasp 200 mm and 250 mm	2 Nos. each
35.	Philips screwdriver with plastic handle 100 mm.	2 Nos.
36.	Philips screwdriver with plastic handle 150 mm	2 Nos.
37.	Blow lamp 1 litre capacity	2 Nos.
38.	Ring spanner or Bihexagon, shallow of set carbon steel chrome plated matric size (various size)	1 set
39.	Portable electrical drill 1/4'' size to work on 230/250 volts AC/DC	1 set
40.	Centre punch with tough point 60 angle knurled type length : 100 mm	2 Nos.
41.	Drift punch 150 mm length 4 mm dia	1 No.
42.	Drift punch 100 mm length 3 mm dia	1 No
43.	Vanadium cold chisel octogonal type drop forged 150 mm	2 Nos.
44.	Vanadium cold chisel octogonal type drop forged 150 mm	2 Nos.
45.	Tool box collapsible type	2 Nos.

Test Bench

1. *Domestic Appliance Test Bench*
   Consisting of A.C. single phase fixed and variable (0-230 V) D.C. supply fixed (230 V) and variable (0-230 V) with necessary protective devices and necessary instruments like ammeter, volt meter etc. The size of the panel meter must be chosen as per the size of the testing table.
2. *Domestic Appliance Service Table*
   The size and number of tables must be decided according to the variety of appliances serviced. The tables may be provided with one or two table fixtures like a bench vice, small fly press, etc.
3. *Winding Table*
   An area may be specified with a table for doing rewinding jobs. A small winding machine with the necessary rewinding tools can also be placed with this table.
4. A small bench grinder, 150 mm wheel diameter, fitted with one course and fine grinding wheel. The motor is preferably to work in single phase A.C. supply.
5. Service trays for storing the disassembled parts of appliances, cleaning of parts, etc. The size and quality of trays may be provided as required.
6. A storage cabinet for the stock of spares.
7. Tools display rack placed in an accessible area for servicing of appliances.
8. Storage cabinet for the stock of appliances received for repairs and storage for repaired appliances.

List of Equipment

1	2	3
1.	Multi meter	1 No.
2.	Ohm meter	1 No.
3.	Megger/insulation tester	1 No.
4.	Single phase rectifier unit to operate 220 to 250 volt A.C. 50 cycle supply with an output of 250 volt.	1 No.
5.	A.C. voltage stabiliser	1 No.
6.	Instant soldering gun 100 W. to work on 230/250 volt	1 No.
7.	Soldering iron with pencil bits 33 volt, 75 volt	2 Nos.
8.	-do- — 25 W	2 Nos.
9.	-do- — 125 W	1 No.
10.	-do- — 250 W	1 No.
11.	Coil winding machine for winding small transformer coil/choke coils/No volt coils and F.H.P. motors.	1 set
12.	Universal growler with adjustable jaw for testing armature to work on 230 V A.C.	1 set
13.	Emergency light to work on a battery	1 set
14.	Tachometer similar to smith type	1 set

List of Indian Standards on Domestic Electrical Appliances

IS · 1956-1970	Specification for polyethylene insulated and PVC sheathed cables upto and including 250 volts.
IS : 694 (Part-I) 1964	Specification for PVC insulated cables (for voltage upto 100 V) with copper conductors.
IS : 694 (Part-II) 1964	Specification for PVC insulated cables (for voltage upto 100 V) with aluminium conductors
IS · 434-1964	Specification for rubber insulated cables
IS : 434 (Part-I) 1964	With copper conductors.
IS : 434 (Part-II) 1964	With aluminium conductors.
IS : 1401-1970	Specification for accessibility test probes.
IS : 3010 (Part-I) 1965	Specification for appliance-connectors
IS : 3010 (Part-II) 1965	Specification for appliance-inlets.
IS : 3724-1966	Specification for carriage type heating elements (non-embedded type).
IS · 6390-1971	Specification for domestic electric clothes washing machines (non-automatic).
IS : 5790-1970	Specification for domestic electric cooking ovens.
IS : 4250	Specification for domestic electric food mixers (liquidizers, blenders and grinders).
IS : 2268-1966	Specification for electric call bells and buzzers for indoor use.
IS : 3514-1966	Specification for electric coffee percolators (non-regulator type).
IS : 1415-1966	Specification for electric hand lamps.
IS : 365-1965	Specification for electric hot plates.
IS : 368-1963	Specification for electric immersion water heaters.
IS : 366-1965	Specification for electric irons.
IS : 367-1965	Specification for electric kettles.

IS : 3481-1966	Specification for electric portable lamp standards and brackets.
IS : 369-1965	Specification for electric radiators.
IS : 3482-1966	Specification for electric saucepans.
IS : 2994-1965	Specification for electric stoves.
IS : 1287-1965	Specification for electric toasters.
IS : 3412-1965	Specification for electric water boilers.
IS : 7153-1973	Specification for electrical controls for household appliances.
IS 5161-1969	Specification for flexible electric heating pads for domestic use.
IS : 302-1973	Specification for general and safety requirements for light electrical appliances.
IS : 6365-1971	Specification for laboratory electric ovens.
IS : 7154-1973	Specification for mains-operated electric dryers.
IS : 5159-1969	Specification for mains-operated electric shavers.
IS : 5160-1969	Specification for mains-operated synchronous clocks.
IS : 6446-1972	Specification for mica-insulated heating elements.
IS : 4159-1967	Specification for mineral-filled sheathed heating elements.
IS : 5579-1970	Specification for neon testers.
IS : 7137-1973	Specification for portable hand-held mains, operated electric massagers.
IS : 7603-1975	Specification for portable low speed food grinding machines.
IS : 3725-1966	Specification for resistance wires, tapes and strips for heating elements.
IS : 1416-1972	Specification for safety transformers.
IS : 959-1966	Specification for electric soldering irons.
IS : 4158-1967	Specification for solid embedded type electric heating elements.
IS : 6290-1971	Specification for steam irons.
IS : 2082-1965	Specification for storage type automatic electric water heaters.
IS : 4165-1967	Specification for thermostats for general purpose electric ovens.
IS : 3017-1965	Specification for thermostats for use with electric water heaters.

Appendix

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